REPORT RESUMES

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RESEARCH MEMORANDUM, EVALUATION OF AN INSERVICE TELEVISION TRAINING PROGRAM IN MATHEMATICS FOR ELEMENTARY TEACHERS.
BY- MILLS, DONALD F. KOPSTEIN, FELIX F.
EDUCATIONAL TESTING SERVICE, PRINCETON, N.J.
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AN EVALUATION WAS CONDUCTED TO ANSWER THREE QUESTIONS--(1) HOW MUCH DID ELEMENTATY SCHOOL TEACHERS WHO VIEWED INSTRUCTIONAL TELECASTS ON MODERN MATHEMATICS KNOW ABOUT THE NEWER MATHEMATICAL CONCEPTS BEFORE THE SERIES OF PROGRAMS BEGAN, AND WHAT WERE THEIR ATTITUDES, (2) HOW MUCH DID THE TEACHERS KNOW, AND HOW MUCH WERE THEIR ATTITUDES CHANGED AFTER VIEWING ALL THE TELECASTS AND PARTICIPATING IN ASSOCIATED ACTIVITIES, AND (3) WERE THE TEACHERS' INCREASED KNOWLEDGE AND POTENTIAL CHANGES IN ATTITUDES REFLECTED IN THEIR OWN CLASSROOM ACTIVITIES IN MATHEMATICS, AND DID THEIR OWN PUPILS' KNOWLEDGE AND ATTITUDES CHANGE AS A RESULT. THE SERIES OF TELECASTS CONSISTED OF 15 30-MINUTE PROGRAMS. TWELVE PILOT CENTERS WERE SET UP IN FOUR MAJOR REGIONAL LOCATIONS. TELECASTS WERE VIEWED AND SEMINAR DISCUSSIONS FOLLOWED. GUIDEBOOKS WERE USED FOR READING AND WORKING EXAMPLES. PRETESTS AND POST-TESTS WERE ADMINISTERED. THREE OBJECTIVE ACHIEVEMENT TESTS WERE USED--(1) THE ETS COOPERATIVE ARITHMETIC TEST, (2) THE ETS COOPERATIVE STRUCTURE OF THE NUMBER SYSTEM TEST, AND (3) A SPECIAL INSIGHTFUL ARITHMETIC TEST. OF THE APPROXIMATELY 350 TEACHERS, IT WAS POSSIBLE TO MATCH 192 PERSONS WHO HAD COMPLETED ALL TESTS AND THE TELECASTS. IT WAS FELT THAT THE TEACHERS DID NOT BENEFIT BY VIEWING THE SERIES OF TELECASTS, NOR DID THE TESTS USED IN THE EVALUATION MEASURE THOSE VARIABLES ON WHICH A CHANGE OCCURRED. (HB)

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RESEARCH MEMORANDUM

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EVALUATION OF AN IN-SERVICE TELEVISION TRAINING PROGRAM IN MATHEMATICS FOR ELEMENTARY TEACHERS

FINAL REPORT

Donald F. Mills and Felix F. Kopstein
Educational Testing Service

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Educational Testing Service
Princeton, New Jersey
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PROJECT STAFF

Project Directors: D. F. Mills (Project Design and Execution)
F. F. Kopstein (Data Analysis and Final Report)

Test Development: S. S. Myers

Research Assistant: B. D. Hanrieder

Secretaries: M. E. Bullock
H. S. Westerberg

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FINAL REPORT OF AN

EVALUATION OF AN IN-SERVICE TELEVISION TRAINING PROGRAM IN MATHEMATICS FOR ELEMENTARY TEACHERS

Section 731 of Part B of Title VII of Public Law 85-864 directs the Office of Education "to disseminate information concerning new educational media to State or local secondary schools, and to institutions of higher education." The law moreover provides for "advice, counsel, technical assistance, and demonstrations to State or local educational agencies and institutions of higher education undertaking to utilize such media of communication to increase the quality or depth or broaden the scope of their educational programs." Under the provisions of this law the Office of Education, in 1961, helped to launch a pilot project for a Northeastern Regional Instructional Television Library (NRITLP) under Contract OE-2-16-011 with the Eastern Educational Network (EEN).

Over the course of the succeeding two years, this project, in collaboration with television station WETA in Washington, D. C., produced a series of programs for the Library which was broadcast over the facilities of the EEN. Early in 1963 the NRITLP began the planning of a series of telecasts intended to familiarize elementary school teachers with some of the newer mathematical concepts now being introduced into the curricula for the first eight grades. In the course of this planning there arose a concern over the effectiveness of such a series and a desire to have some objective, empirical and diagnostic information for amplifications or revisions of scripts covering each of the telecasts in the series. It was reasoned that such a "feedback" could significantly improve the effectiveness of the final product to be stored in the

NRITLP for later re-use. Further, it seemed reasonable to store only programs of high quality and demonstrated effectiveness and to disseminate not only information about the existence of instructional telecasts but, also, data concerning their ability to teach as intended.

These concerns led the Director of the NRITLP, on a mandate from her advisory committee, to approach Educational Testing Service (ETS) with a request for an evaluation. It was proposed that the evaluation should aim to answer these general questions:

1. How much did elementary school teachers, who would be viewing the telecasts, know about the newer mathematical concepts before the series of programs began, and what was their attitude toward issues in the teaching of mathematics?
2. How much will these teachers know and how much will their attitudes change after viewing all of the telecasts and participating in associated activities?
3. Will the teachers' increased knowledge and potential changes in attitudes be reflected in their own instructional classroom activities in mathematics and, consequently, will their own pupils' knowledges and attitudes change significantly?

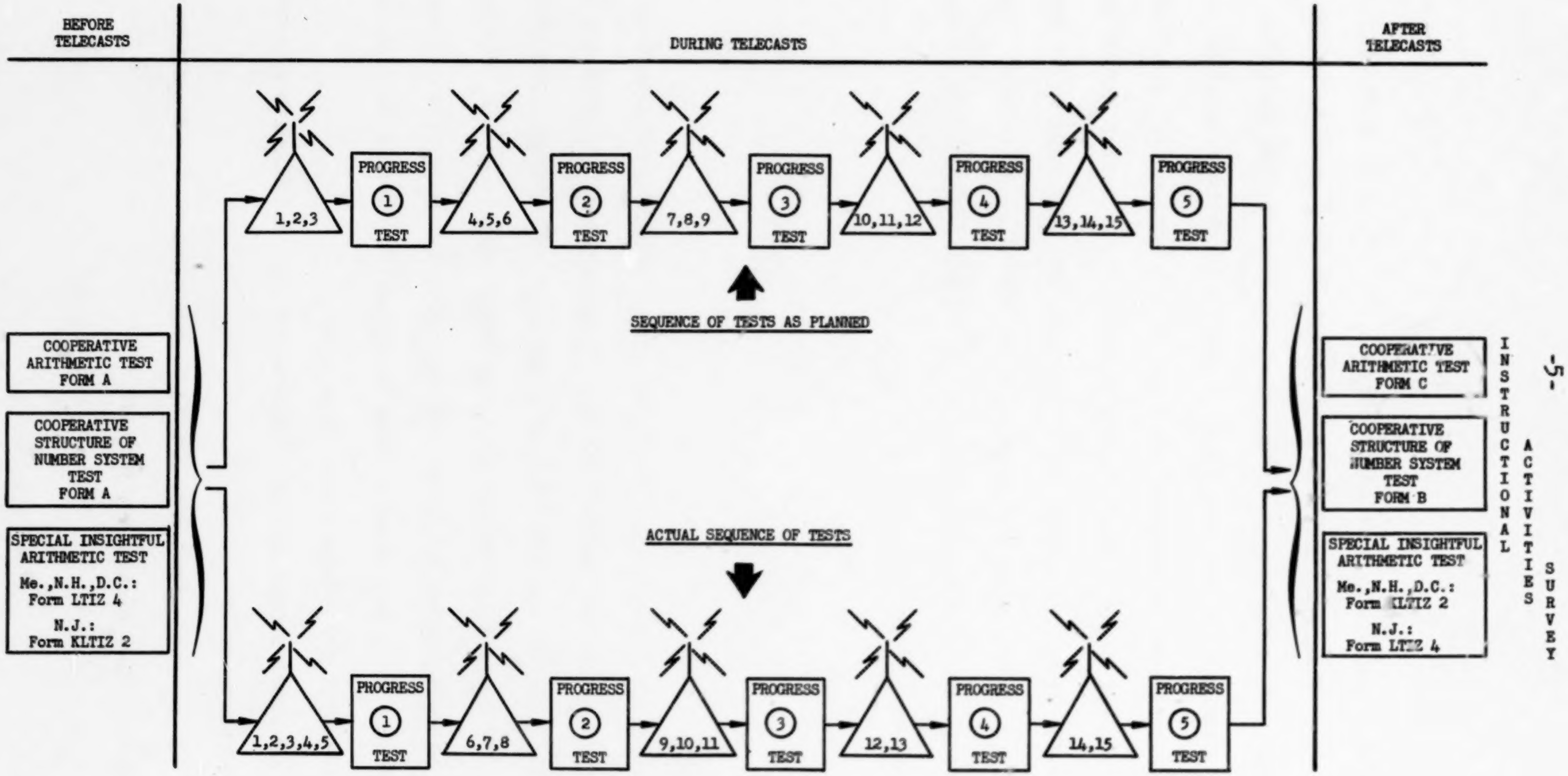
On their face these questions have a self-evident rationale for makers of decisions concerning the production and use of the telecast series. However, they fall short of the standards of clarity and precision that would permit a scientifically sound and rigorous evaluation to be made. For example, the third question represents a highly conditional hypothesis. Stated in a less sweeping and also less ambiguous form it might read thus: _If_ the telecasts engender an increase in the viewing teachers' knowledge of the mathematics in question that cannot be attributed to the passage of time and of ordinary events within it, and if an actual increase of knowledge leads them to introduce these newly learned mathematical concepts into the curricula of their own classrooms, and if they can teach these concepts effectively to their pupils, then will their pupils' knowledge of the mathematics in question increase beyond the gain normally expected of them? Note that the pupils' learning gains would have to be over and above those of their peers being taught by non-viewing teachers, and that these measured gains are conditional upon each each of the three clauses introduced by "if." Should any of these ifs fail to occur, one could not reasonably expect to measure an effect on the pupils. On the other hand, should there be a measured effect on them while the required conditions are not met, this effect could not be attributed to the telecasts. Thus, before a causal relation could be established between the telecasts and pupils' gains the actual occurrence of each of the conditional events would have to be verified. Whatever has been said here about changes in knowledge applies equally for changes in attitudes. Another example, whose import will be clear from the previous reasoning, has to do with measured changes of teachers' knowledge and attitudes. Such changes, if they are to be univocally related to the telecasts, must be supported by proofs that teachers in the sample did, in fact, view all of the telecasts and complete associated activities.

It should not be necessary to illustrate further. A truly rigorous evaluation would have required a very large experimental design incorporating many control groups to which measurements on the experimental groups could have been referred. When the evaluation proposal was originally outlined to the Office of Education in order to explore the possibilities of adjunct support, it became clear that the incorporation of these control groups and procedures would unduly inflate the costs. These costs had to be weighed against the costs of the television series itself and against the needs for support of other activities covered by Title VII of Public Law 85-864. In establishing Contract OE 4-16-004 between the Office of Education and Educational Testing Service, the administrative decision was made to limit the evaluation largely to empirical, diagnostic procedures useful for the revisions of final telecast scripts and to accept penalties of diminished rigor and generality in the overall interpretation. It is in this light that the present, final report of the evaluation must be viewed.

PLAN OF EVALUATION

The basic schema for the evaluation research is outlined in Fig. 1. Teachers in the evaluation sample were tested with three separate and independent mathematics achievement tests in the areas to be covered by the telecasts. These tests were administered prior to the commencement of the telecasts. After the teachers had viewed the first three telecasts in the series, the first of five progress or unit tests was administered. These Unit Tests were especially constructed to fit the content of appropriate telecast scripts so that they could also serve as diagnostic tools for uncovering weak presentations in the material that had been covered. Thereafter, teachers viewed another group of three telecasts, then took the second of the series of Unit Tests and so forth until all of the telecasts in the series had been seen and all of the Unit Tests had been administered. Following the completion of the telecast series, alternate forms of the same tests that had been taken

FIG. 1 SIMPLIFIED SCHEMA OF RESEARCH DESIGN (TEACHERS ONLY)


BEFORE TELECASTS
DURING TELECASTS
AFTER TELECASTS
COOPERATIVE ARITHMETIC TEST FORM A
COOPERATIVE STRUCTURE OF NUMBER SYSTEM TEST FORM A
SPECIAL INSIGHTFUL ARITHMETIC TEST
Me.,N.H.,D.C.: Form LTIZ 4
N.J.: Form KLTIZ 2
1,2,3
PROGRESS ① TEST
4,5,6
PROGRESS ② TEST
7,8,9
PROGRESS ③ TEST
10,11,12
PROGRESS ④ TEST
13,14,15
PROGRESS ⑤ TEST
SEQUENCE OF TESTS AS PLANNED
ACTUAL SEQUENCE OF TESTS
1,2,3,4,5
PROGRESS ① TEST
6,7,8
PROGRESS ② TEST
9,10,11
PROGRESS ③ TEST
12,13
PROGRESS ④ TEST
14,15
PROGRESS ⑤ TEST
COOPERATIVE ARITHMETIC TEST FORM C
COOPERATIVE STRUCTURE OF NUMBER SYSTEM TEST FORM B
SPECIAL INSIGHTFUL ARITHMETIC TEST
Me.,N.H.,D.C.: Form KLTIZ 2
N.J.: Form LTIZ 4
INSTRUCTIONAL
ACTIVITIES
SURVEY

before the series began were administered. In addition, each teacher was given a copy of an Instructional Activities Survey (covering Teachers' Background, Attitudes toward Mathematical Activities, and Attitudes toward Teaching Mathematics) and was asked to return it after completing it.

Pupils of some 45 selected teachers in the sample were also included in the original plans. These pupils were similarly tested before the series of telecasts began and before their teachers had been exposed to them. They were then retested after the conclusion of the telecast series. During the series they simply attended school in the normal fashion, and no special treatment was involved.

PROCEDURE

Telecasts

The series consisted of 15 thirty-minute programs and was developed under the supervision of the NRITLP (1963). It was produced by WETA the Washington, D. C. affiliate of the EEN. The programs were rebroadcast from video tapes through ETV outlets in Presque Isle and Orono, Maine; Durham, New Hampshire; Boston, Massachusetts; New York City; Pittsburgh, Pennsylvania; and Washington, D. C. From within the areas covered by these ETV outlets four major locations were chosen for the evaluation. They were:

1. A rural school system--Milford-Bradley, Maine, with approximately 500 elementary pupils.

2. A moderate sized city school system--Dover, New Hampshire, with approximately 2500 elementary pupils.

3. A suburban school system--Englewood, New Jersey, with approximately 4000 elementary pupils.

4. A large urban school system--District of Columbia, with approximately 85,000 elementary pupils.

Twelve pilot centers were set up within these four major locations. A pilot center consisted of a place--usually a school--where participating teachers would meet for the following purposes:

1. Viewing of the telecasts.

2. Participating in seminar discussions under the direction of leaders who had been trained in a special two-week workshop conducted by the television series master teacher at Tufts University during the summer of 1963.

3. Reading and working examples in a guidebook designed by the television master teacher (Boisclair, 1963a-o) for the participants and other interested viewers.

4. Taking of the five Unit Tests which were followed by seminar discussions and of the pretests and posttests.

Tests and Testing

There were three objective achievement tests used in the overall evaluation. They were:

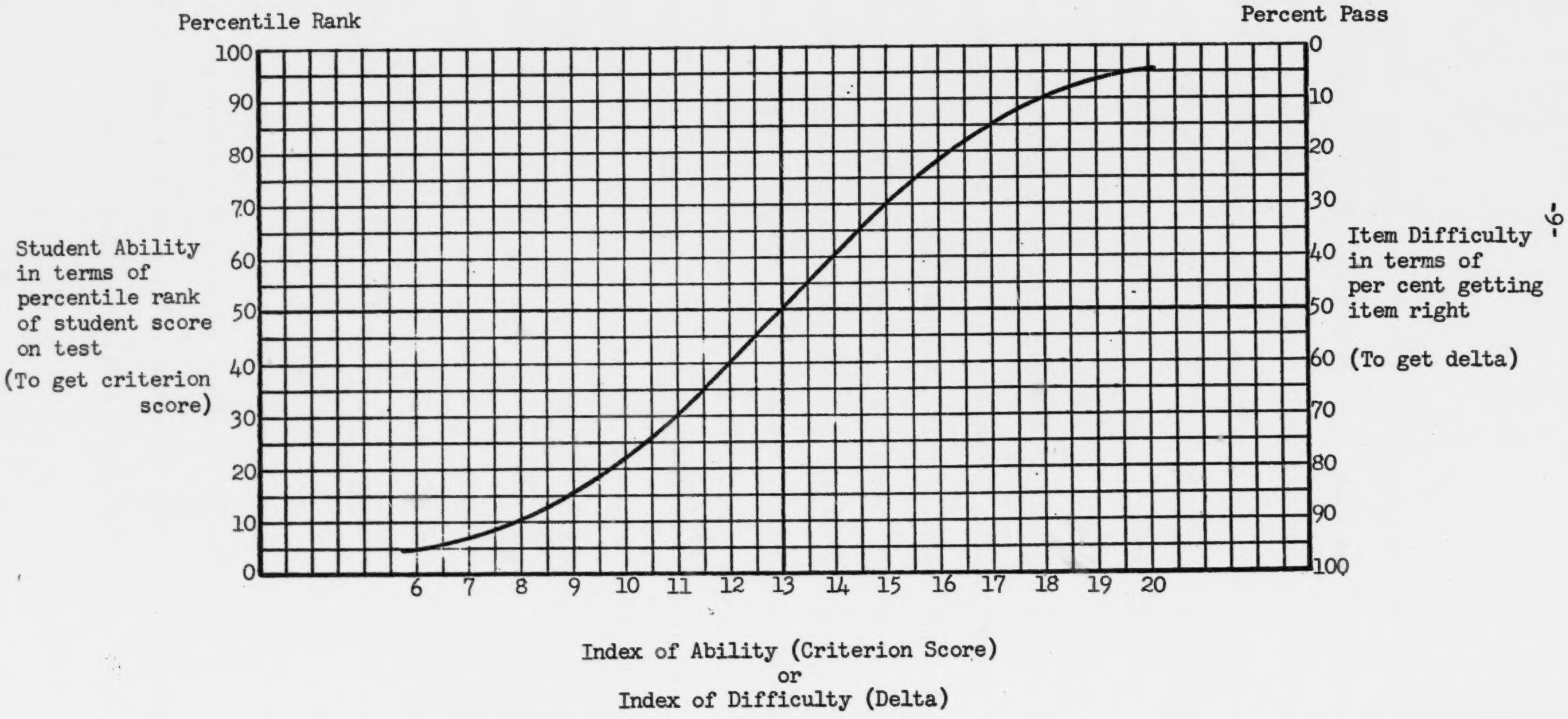
1. The ETS Cooperative Arithmetic Test
2. The ETS Cooperative Structure of the Number System Test
3. A special Insightful Arithmetic Test

Of these the first two are standard tests published by the Cooperative Test Division of Educational Testing Service. Their development, characteristics, and other technical data are given in the standard handbook which is incorporated into this report as Appendix A. Hence, no further description of them will be given here. Also, standard directions for their administration and scoring are given in this manual. The third test was especially developed for the present study by the Mathematics Section of ETS' Test Development Division.

The Insightful Arithmetic Test (IAT) consisted of 40 multiple choice items for which one hour was allowed. As the test's title suggests its content was arithmetic, but its items dealt with arithmetical concepts rather than with numerical manipulation and operational procedures. The test was constructed from items in the file of the Test Development Division. Data for each item had been previously obtained from a Scholastic Aptitude Test population. These data included the item's content, its r_{bis} with the total test score as well as the mean and standard deviation of its Delta. The latter is an index of an item's difficulty whose determination is shown graphically in Fig. 2. Since, as it will be seen later, it was necessary to construct several forms of the IAT, an attempt was made to distribute items with closely matching characteristics into each of the forms so that a mean Delta of about 12.5 might be obtained for each of the test forms. It will be important to appreciate that none of the items and none of the complete tests were standardized prior to their use in the present study, nor were the data that were used in designing an a priori "equivalence" of the test forms obtained from a population comparable to that participating in the study.

All tests used for evaluation purposes were administered in two equivalent (or presumably equivalent) forms. In the case of the Cooperative Arithmetic

FIG. 2 COMPOSITE GRAPH
FOR DETERMINING STUDENT CRITERION SCORE (ABILITY INDEX)
OR DELTA OF A QUESTION (DIFFICULTY INDEX)
WHEN THERE IS NO DROP-OUT



by S.S. Myers
March 28, 1962

Test, Form A was administered as the pretest prior to viewing the telecasts, and Form C was administered as the posttest after the end of the telecasts. No attempt was made to have a balanced split in test forms that would be reversed in the posttests. The evidence for regarding Forms A and C as equivalent is presented in Appendix A. For the Cooperative Structure of the Number System Test, Form A served as the pretest and Form B served as the posttest. Again, no balanced split was attempted. Equivalence data may be found in Appendix A. For the Insightful Arithmetic Test, two forms were prepared and used, designated LTIZ-4 and KLTIZ-2 respectively. For participating teachers in Maine, New Hampshire, and the District of Columbia, Form LTIZ-4 served as the pretest and Form KLTIZ-2 as the posttest, while for participating teachers in New Jersey, this order was reversed.

Pretesting in Maine, New Hampshire, and the District of Columbia took place during October of 1963. For teachers in Englewood, N. J., the pretests were not held until January of 1964, since telecasts in the area were not scheduled to begin until the second semester of the 1963-64 academic year. Posttests were administered during May and the first week of June. Two of the tests were administered on the same day and the third test administered soon thereafter. All tests were administered according to standard procedure. For the Cooperative Tests, these procedures are described in Appendix A. For the IAT, the procedures are given in Appendix B. Incorporated into the IAT test booklets was a teacher background questionnaire, which had nothing to do with the test proper, and which was, however, not actually used.

The Unit Tests used to measure progress throughout the telecast series and as diagnostic tools for the revision of the scripts were prepared in only a single form. These tests were designated LTIZ 5 through 9. Items comprising these tests were developed by ETS' Test Development Division from advance copies of the scripts for the appropriate telecasts that were supplied by the NRITLP. Subsequently, scripts were somewhat changed prior to taping of even the basic telecasts so that test content did not always match the content of the telecasts perfectly. After telecasts were completed and item analyses for these test items could be made, the tests were revised and the revised versions were furnished to the NRITLP for further use in conjunction with rebroadcasts of the series. Administration of the Unit Tests was in accordance with standard procedures described in Appendix B.

Instructional Activities Survey

Throughout the administrations of the pretests and of the Unit Tests, certain attitude and survey items had been given a trial use with small subsamples of the participating teachers. From these items a three-part Instructional Activities Survey was constructed. The three parts covered (1) teachers' backgrounds, (2) attitudes toward mathematical activities, and (3) attitudes toward the teaching of mathematics. These Instructional Activities Surveys (IAS) were given to teachers after they had completed the final posttest together with self-addressed, postage paid envelopes, and they were requested to complete and return the booklets as soon as possible. Possibly due to the work-pressure near the end of the school year few teachers complied with the request. Consequently, a follow-up mailing was made in November of 1964. This follow-up had only moderate success and by no means did all of the participating teachers, or even only those who completed pretests and posttest as well as the entire series of telecasts and Unit Tests, return the IAS. Of those who did return booklets some did not respond to all questions, or, in some cases, to any of the questions. There were 12 unmarked booklets returned. The IAS booklet with frequencies of responses of the 143 returnees to each item recorded in the appropriate space constitutes Appendix C of this report.

RESULTS

There were some 355 teachers formally registered in the course at one time or another. This does not mean, however, that complete data were obtained from 355 individuals. Not all of the participating teachers took all of the pretests. For example, only 340 persons completed the pretest form of the Cooperative Structure of the Number System (SNS) Test, and even fewer, i.e., 334 persons, took the Cooperative Arithmetic pretest. Oddly enough some 362 persons in Maine, New Hampshire, and the District of Columbia alone returned answer sheets for the pretest forms of the Insightful Arithmetic Test (IAT). Some 33 more participated in the Englewood, N. J. area. In other words, due to the dispersion of participants and the lack of direct control over them, it is difficult to establish precisely how many teachers were actually in the study at one time or the other and what accounted for the fluctuation in numbers. It is certain that the numbers mentioned above in no way suggest that the same individuals were involved. Thus, while 334 persons took the Cooperative Arithmetic pretest, this does not mean that all of these individuals also took the Cooperative SNS pretest or the IAT pretest.

It was possible to match some 192 persons who had completed both the pretest and the posttest of the cooperative Arithmetic Test, 185 persons who had similarly completed both forms of the Cooperative SNS Test and 187 who had completed both forms of the IAT. One hundred forty-three teachers returned their copies of the Instructional Activities Survey (IAS), but only 131 booklets contained responses to at least some of the items.

Participants and Their Characteristics

Of those who returned completed IAS booklets, some 85% were women, some 12% were men, and 3% declined to declare themselves. The raw data from which these and subsequent percentages are taken may be found in Appendix C.

The distribution of participating teachers' ages is shown in Fig. 3. It will be seen that their ages ranged from 24 years or less to 60 years or more with a fairly even distribution of ages between the extremes. The median age of the teachers was between 40 and 44 years.

The educational levels of participating teachers are shown in Fig. 4. One of the participants had received the doctorate. The group constituting the largest single category held no more than the baccalaureate. There were 13 teachers who had not earned a bachelor's degree, but the median teacher held that degree and had accumulated one year of advanced study beyond it.

Fig. 5 shows that, as a group, the participants were highly experienced teachers. Only three of the 130 respondents were in their first year of teaching, while 17 had 30 or more years of teaching behind them. The

FIG. 3 AGE DISTRIBUTION OF PARTICIPANTS

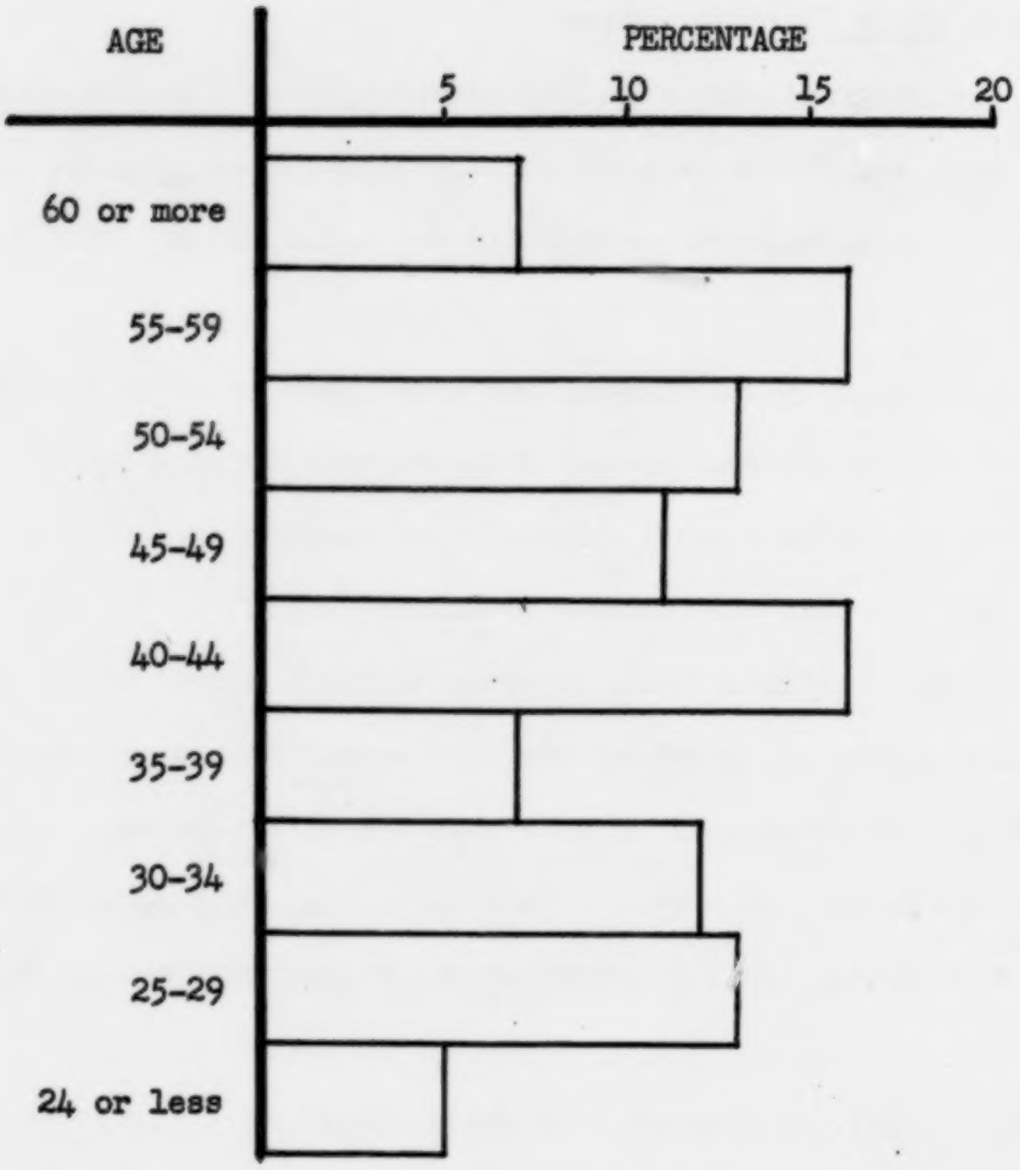


FIG. 4 EDUCATIONAL LEVELS OF PARTICIPANTS

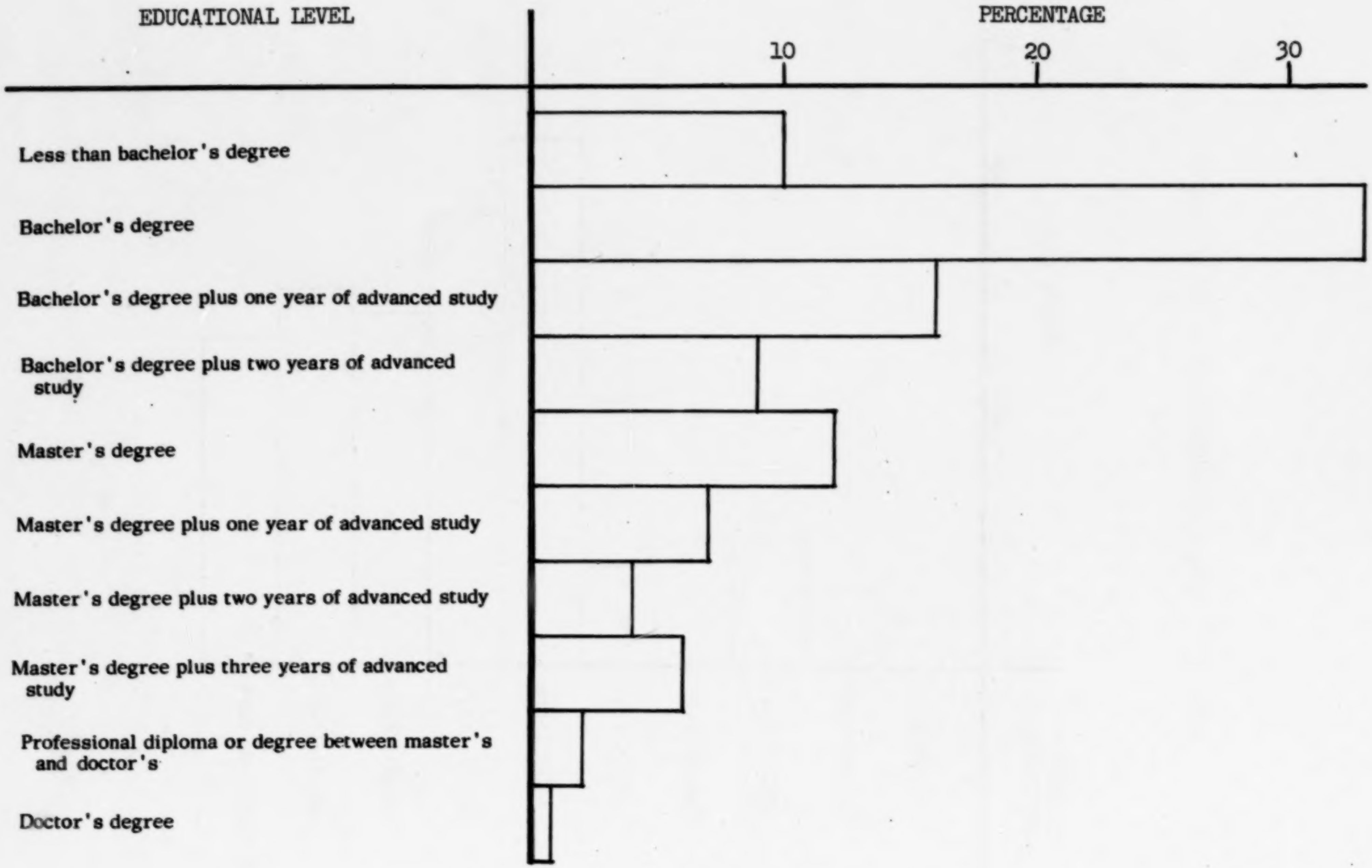
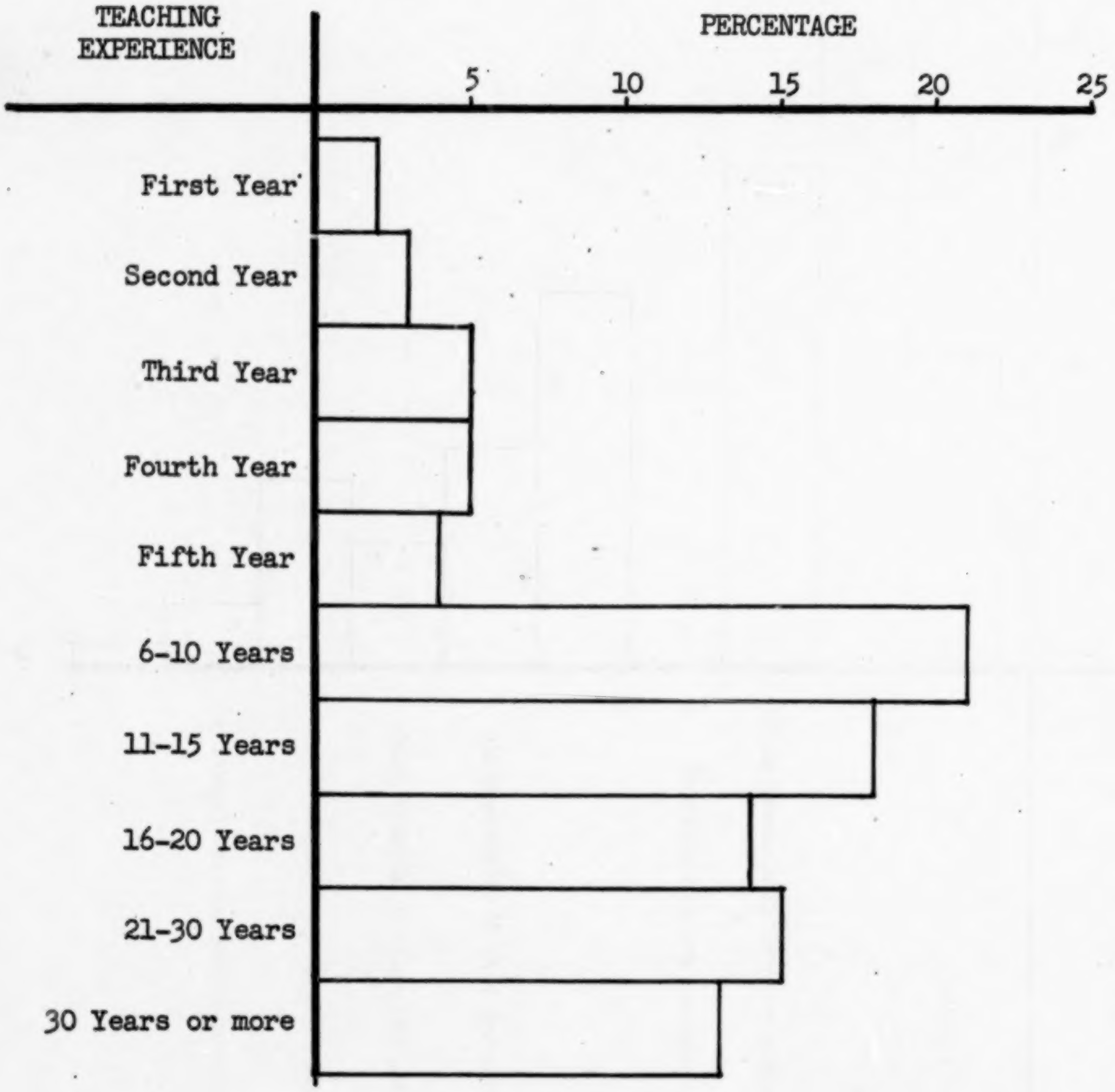


FIG. 5 TEACHING EXPERIENCE OF PARTICIPANTS



median number of years of teaching experience for these teachers was 11 to 15 years. Eighty-one percent of the participants had been teaching for six years or more.

For the median teacher, the last exposure to a college-level course with mathematical content (including methods courses on teaching arithmetic) lay some three years in the past. For some 29% of the group, this experience seems to have dated back more than five years. About 12% of the respondents (N = 126) implied that they had never taken a mathematical course, or that such an exposure had taken place a very long time ago. Additional characteristics of participants may be gleaned from Appendix C.

Unit Tests

All five of the Unit Tests (UN-1 through UN-5) were administered to the participating teachers in Maine, New Hampshire, and New Jersey. Production problems prevented the use of UN-4 and UN-5 in the District of Columbia. Although Unit Tests were originally scheduled to follow every third telecast, exigencies arising in the course of the study dictated deviations from that schedule. UN-1 followed the fifth telecast, UN-2 followed the eighth telecast, UN-3 followed the eleventh telecast, UN-4 followed the thirteenth telecast, and UN-5 followed the fifteenth and final telecast. There was, of course, no guarantee that teachers taking each Unit Test had actually viewed each of the preceding telecasts.

Data pertaining to the five Unit Tests are summarized in Tables 1 and 2. From Table 1, it may be seen that mean scores for the five tests varied from 8.4 (Test 1) to 11.5 (Test 4) raw score points. Standard deviations varied from 3.2 (Tests 2 and 3) to 4.4 (Test 5) answers correct. The number of

TABLE 1

Means, Standard Deviations, and Percentile Distributions of the Five Unit Tests

Approximate Percentile Rank	Test Identification[a] and Scores				
	UN-1	UN-2	UN-3	UN-4	UN-5
99	19	18	19	20	19
95	16	16	16	19	17
90	14	14	14	18	16
75	12	12	12	15	13
50	8	10	9	12	9
25	6	8	7	9	7
10	3	6	6	7	4
5	2	5	5	5	3
1	1	3	4	4	1
Test Mean	8.4	9.7	9.2	11.5	9.3
Test Standard Deviation	4.0	3.2	3.2	4.0	4.4
No. Teachers	265	175	235	98	100

[a] Test Identification:

UN-1: First Achievement Test (After Program 5) (20 items)
UN-2: Second Achievement Test (After Program 8) (20 items)
UN-3: Third Achievement Test (After Program 11) (20 items)
UN-4: Fourth Achievement Test (After Program 13) (20 items)
UN-5: Fifth Achievement Test (After Program 15) (20 items)

responses correctly given varied from a low of one point (Tests 1 and 5) to a high of 20 points (Test 4). These data and other data summarized in this report are based on N's ranging between 98 (Test 4) and 265 (Test 1). The large attrition for the last two tests is due to the exclusion of the Washington teachers.

The item analysis procedures employed in this study were carried out by the Statistical Analysis Division of ETS. Data considered germane to this report were the indices of difficulty. The index of difficulty (Delta), helps in establishing the difficulty of a particular item on the test. If an item on the test had a difficulty index in excess of 16.75, it could be said that the item was quite difficult, whereas a difficulty index less than 9.25 would lead to the interpretation that an item was quite easy (cf. CEEB, 1956).

Examination of the information contained in Table 2 shows that 11 items on all five of the Unit Tests had difficulty indices less than or equal to 9.25; 29 items less than or equal to 11.75; 41 items between 11.75 and 14.25; 30 items greater than or equal to 14.25; and five items with indices greater than or equal to 16.75. The average index for the 100 items was 13.8, with a standard deviation of 2.36. These data indicate that the 100 (total) test items had difficulty levels which were approximately normally distributed.

The 30 items which proved most difficult to the participating teachers were discussed in detail by Mills (1964) and are briefly categorized below:

1. Additive properties of the set of integers.
2. Conditions under which a set is closed with respect to various operations.
3. Subtraction as the inverse of addition.

TABLE 2

Numbers of Items in Each of the Unit Tests at Each of Five Levels of Difficulty

Test Unit	Difficulty Level (Delta)					Total Number of Items
	9.25 or Less (82.5%+)[a]	9.25-11.75 (82.5%-62.5%)	11.75-14.25 (62.5%-37.5%)	14.25-16.75 (37.5%-16%)	16.75 or More (16%-)	
UN-1	1	3	10	5	1	20
UN-2	2	4	7	5	2	20
UN-3	4	0	9	5	2	20
UN-4[b]	3	6	8	3	0	20
UN-5[b]	1	5	7	7	0	20
All Items	11	18	41	25	5	100[c]

[a] Percentages given in parentheses refer to corresponding proportions of examinees passing items at indicated Delta levels.

[b] Mean difficulty indices for Tests 4 and 5 estimated on the basis of item counts and Figure 1 (Myers, 1964).

[c] Average difficulty index for all 100 items = 13.8; SD = 2.36.

4. Division as the inverse of multiplication.
5. The concept of proper subsets.
6. The cardinal numbers associated with members of sets.
7. Abstraction of properties of and operations on the number line.
8. Properties of one as an identity element.
9. Concepts of reciprocals.

Other difficulties noted from the item analysis of the 100 items (total) on the five Unit Tests included:

1. Properties of the empty set.
2. Concepts related to unions and interactions of sets.
3. Graphical interpretation of sets.
4. Translation of larger-order nonbase-10 numerals into base 10.
5. Visualization of operational principles of the abacus.
6. The relative values of the results of multiplication of proper fractions.
7. Relationships between the set of positive numbers and the set of positive integers.
8. Interpretation of the various meanings of the division operation with reference to specific problem-solving situations.
9. The distributive, associative, and commutative properties of multiplication.
10. Conditions under which finite decimals may be derived.
11. Abstraction of the concepts of "less than" and "greater than" relationships with reference to the operations of addition and multiplication.

12. Additive and multiplicative inverses.

13. Dealing with novel operations and signs.

14. Reading problems carefully without making unwarranted assumptions.

There were 29 items which seemed to present relatively little difficulty to the teachers who took the unit tests. These items seemed to fit into the categories outlined below:

1. Equivalence of sets.
2. Use of the abacus to represent place value.
3. Working with distributive, commutative, and associative properties of multiplication with whole numbers.
4. Visualization of operations on and relative positional values of points on the number line.
5. Converting improper fractions to whole numbers (with or without remainders).
6. Working with operations charts related to base 10 and nonbase-10 numbers.
7. Addition within the set of positive and negative integers.
8. Understanding place values in base 10 numeration.
9. Estimating correct answers to calculations.
10. Writing decimal numbers in expanded notation.
11. Division as repeated subtraction.
12. Multiplication as the union of disjoint sets.
13. Binary operations on the set of integers.
14. Representing small nonbase-10 numbers in base 10.
15. Converting fractions to decimal notation.

All of this information was communicated to the TV production staff and to the NRITLP as soon as it became available. It served as the basis for revisions in the scripts of the telecasts which were re-taped late in 1964.

Apparent Effects of Instruction

The effects of the televised instruction can be considered separately for each of the three independent measures (tests) of achievement related to the mathematical content of the series. In order to do so, an assumption of exact equivalence of test forms must be made. The tenability of that assumption will be discussed later. Similarly, an assumption must be made that a control group taking only the tests, but receiving no instruction during the interim, would have shown no gains.

The apparent gains from pretest to posttest for mathematical knowledge measured by the Cooperative Arithmetic Test are presented in Table 3. Only those cases (participants) are represented for whom both a pretest and a posttest score had been obtained. It can be seen that pretest and posttest means are virtually identical and that the difference between them, representing the "gain" in achievement, is null. This is evident as well from the standard error of the mean difference (four times greater than the difference itself) and the size of the standard deviation, and it is confirmed by the calculated value of $\underline{t}$ which is convertible to a probability greater than 50% that the obtained difference is due only to a sampling error.

Results for the Cooperative SNS Test are slightly different. These results are presented in Table 4. Again, only those cases are included for whom both a pretest and a posttest score had been obtained. A gain of 4.4 raw score points is apparent. The seeming difference of the gain from the difference between pretest and posttest means is due to rounding. In order

TABLE 3

Cooperative Arithmetic Test

(N = 192)

	Mean	Standard Deviation		Mean ± Std. Error	Standard Deviation	t
Pretest (Form A)	34.6	8.4	Difference	0.1 ± 0.4	5.6	0.02[a]
Posttest (Form C)	34.7	9.7				

[a] $p > .50$

TABLE 4

Cooperative Structure of the Number System Test

(N = 185)

	Mean	Standard Deviation		Mean ± Std. Error	Standard Deviation	t
Pretest (Form A)	16.0	6.4	Difference	4.4 ± 0.3	4.6	13.0[a]
Posttest (Form B)	20.5	7.8				

[a] $p < .001$

to obtain a distribution of difference scores, the pretest scores of every participant were subtracted from his posttest scores. Thus the mean of the differences rather than the difference between the means is given here and in the comparable tables above and below. The obtained mean of the differences clearly is greater than zero, and this is borne out by the calculated t value which suggests a probability of less than once in a thousand that this obtained difference could have arisen by chance.

Results are somewhat more ambiguous in the case of the IAT. These results are shown in Table 5. Here, too, only cases (teachers) for whom both pretest and posttest scores existed were included. Table 5 presents first the apparent gains on the IAT without regard to the order of use for the test forms involved. Next, it shows results for those teachers in Maine, New Hampshire, and the District of Columbia who were pretested with Form LTIZ 4 and posttested with Form KLTIZ 2. Finally it shows the results for teachers in New Jersey who were pretested with Form KLTIZ 2 and posttested with Form LTIZ 4, i.e., a reverse order of tests from the rest of the group. Viewed without regard to location and test order a mean gain from pretest to posttest of 2.1 additional correct responses was achieved. This apparent mean gain is even greater when only those teachers are considered whose test order was LTIZ 4 - KLTIZ 2 increasing in that case to 3.2 additional correct responses. Both of these mean gains are statistically highly significant, i.e., the possibility of their having arisen by chance is less than one in 1000. However, reverse results were obtained, when only those 17 teachers in New Jersey are considered whose test order was KLTIZ 2 - LTIZ 4. Their absolute level of achievement is slightly higher, but they show a loss between pretest and posttest scores as evidenced by the negative difference

TABLE 5

Insightful Arithmetic Test
(Total N = 187)

	Mean	Standard Deviation		Mean ± Std. Error	Standard Deviation	t
Pretest	19.5	7.5	Difference	2.1 ± 0.3	4.4	6.5[a]
Posttest	21.6	7.7				
(Me, N.H., & D.C.; N = 170)						
Pretest (LTIZ 4)	18.8	7.0	Difference	3.2 ± 0.3	4.5	9.3[a]
Posttest (KLTIZ 2)	21.4	7.6				
(N.J.; N = 17)						
Pretest (KLTIZ 2)	27.4	7.4	Difference	-3.5 ± 1.0	4.0	3.5[a]
Posttest (LTIZ 4)	23.9	7.8				

[a] $p < .001$

between these scores. The absolute size of that difference is numerically just slightly larger than that obtained with the reverse test order while the variability around it is numerically just slightly smaller. Presumably due to the fact that the number of observations in the case of the 2 - 4 order is exactly 1/10 of the number for the 4 - 2 order the calculated value of *t* is smaller, but nevertheless indicates that this diametrically opposite result could have arisen by chance only once in a thousand times.

Attitudes and Opinions

Complete results of the Instructional Activities Survey (IAS) will be found in Appendix C. The detailed results will not be recapitulated here. Rather the salient features of teachers' attitudes and opinions about classroom instructional activities in mathematics and about issues in mathematics teaching as a professional activity are brought into relief.

Teachers' views of 12 selected classroom instructional activities are outlined in Table 6. For each of the 12 activities the teachers were asked to provide 10 ratings. The 10 ratings were in five categories. For each item then, the schema was as follows:

Familiarity with and use of activity	**Know**	☐ ☐ ☐ ☐	**Don't know**
	Do it often	☐ ☐ ☐ ☐	**Seldom or never do it**
Activity's character	**Mathematical**	☐ ☐ ☐ ☐	**Not mathematical**
Activity's value	**Useful**	☐ ☐ ☐ ☐	**Not useful**
	Not important	☐ ☐ ☐ ☐	**Important**
	Boring	☐ ☐ ☐ ☐	**Interesting**
Pupil's attitude toward activity	**Fun**	☐ ☐ ☐ ☐	**Not fun**
	Easy	☐ ☐ ☐ ☐	**Hard**
	Slow	☐ ☐ ☐ ☐	**Fast**
Self-estimate relative to activity	**Good at it**	☐ ☐ ☐ ☐	**Not good at it**

TABLE 6

TEACHERS' VIEWS OF INSTRUCTIONAL ACTIVITIES RELATED TO MATHEMATICS

(N_{max} = 131)

1. ENUMERATION (CARDINAL AND ORDINAL)

Know	■	☐	☐	☐	Don't know
Do it often	☐	■	☐	☐	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	■	⊡	Interesting
Fun	⊡	■	☐	☐	Not fun
Easy	☐	■	☐	☐	Hard
Slow	☐	☐	■	☐	Fast
Good at it	☐	■	☐	☐	Not good at it

2. WRITING STORY PROBLEMS

Know	■	☐	☐	☐	Don't know
Do it often	☐	■	☐	☐	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	☐	■	Interesting
Fun	⊡	■	☐	☐	Not fun
Easy	☐	☐	■	☐	Hard
Slow	☐	☐	■	☐	Fast
Good at it	☐	■	☐	☐	Not good at it

3. USING A PEGBOARD

Know	■	☐	☐	☐	Don't know
Do it often	☐	☐	☐	■	Seldom or never do it
Mathematical	⊡	■	☐	☐	Not mathematical
Useful	⊡	■	☐	☐	Not useful
Not important	☐	☐	■	☐	Important
Boring	☐	☐	■	☐	Interesting
Fun	☐	■	☐	☐	Not fun
Easy	⊡	■	☐	☐	Hard
Slow	☐	☐	■	☐	Fast
Good at it	☐	■	☐	☐	Not good at it

4. ADDITION WITH WHOLE NUMBERS

Know	■	☐	☐	☐	Don't know
Do it often	■	☐	☐	☐	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	☐	■	Interesting
Fun	⊡	■	☐	☐	Not fun
Easy	⊡	■	☐	☐	Hard
Slow	☐	☐	■	☐	Fast
Good at it	■	☐	☐	☐	Not good at it

5. DEVELOPMENT OF CONCEPTS OF FRACTIONS

Know	■	☐	☐	☐	Don't know
Do it often	⊡	■	☐	☐	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	☐	■	Interesting
Fun	⊡	■	☐	☐	Not fun
Easy	☐	■	☐	☐	Hard
Slow	☐	☐	■	☐	Fast
Good at it	☐	■	☐	☐	Not good at it

6. WORKING WITH MENSURATION FORMULAS FOR AREA, VOLUME, AND PERIMETER

Know	⊡	■	☐	☐	Don't know
Do it often	☐	☐	■	⊡	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	■	⊡	Interesting
Fun	☐	■	☐	☐	Not fun
Easy	☐	☐	■	☐	Hard
Slow	☐	■	☐	☐	Fast
Good at it	☐	■	☐	☐	Not good at it

7. MANIPULATION OF SYMBOLS

Know	■	☐	☐	☐	Don't know
Do it often	⊡	■	☐	☐	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	■	☐	Interesting
Fun	☐	■	☐	☐	Not fun
Easy	☐	■	⊡	☐	Hard
Slow	☐	☐	■	☐	Fast
Good at it	☐	■	☐	☐	Not good at it

8. SOLVING INCOMPLETE DATA PROBLEMS

Know	■	☐	☐	☐	Don't know
Do it often	☐	☐	■	⊡	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	■	⊡	Interesting
Fun	☐	■	☐	☐	Not fun
Easy	☐	☐	■	☐	Hard
Slow	☐	■	☐	☐	Fast
Good at it	☐	■	☐	☐	Not good at it

9. FINDING AVERAGES

Know	■	☐	☐	☐	Don't know
Do it often	⊡	■	☐	☐	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	☐	■	Interesting
Fun	⊡	■	☐	☐	Not fun
Easy	⊡	■	☐	☐	Hard
Slow	☐	☐	■	☐	Fast
Good at it	⊡	■	☐	☐	Not good at it

10. WORKING ALGEBRA PROBLEMS

Know	⊡	■	☐	☐	Don't know
Do it often	☐	☐	☐	■	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	■	☐	☐	☐	Not useful
Not important	☐	☐	☐	■	Important
Boring	☐	☐	■	⊡	Interesting
Fun	☐	■	☐	☐	Not fun
Easy	☐	☐	■	☐	Hard
Slow	☐	■	☐	☐	Fast
Good at it	☐	☐	■	☐	Not good at it

11. WRITING MUSIC

Know	☐	☐	■	⊡	Don't know
Do it often	☐	☐	☐	■	Seldom or never do it
Mathematical	⊡	■	☐	☐	Not mathematical
Useful	⊡	■	☐	☐	Not useful
Not important	☐	☐	■	☐	Important
Boring	☐	☐	■	⊡	Interesting
Fun	☐	■	☐	☐	Not fun
Easy	☐	☐	■	⊡	Hard
Slow	☐	■	☐	☐	Fast
Good at it	☐	☐	■	⊡	Not good at it

12. WORKING WITH CONCEPTS OF PROBABILITY

Know	☐	☐	■	⊡	Don't know
Do it often	☐	☐	☐	■	Seldom or never do it
Mathematical	■	☐	☐	☐	Not mathematical
Useful	⊡	■	☐	☐	Not useful
Not important	☐	☐	■	⊡	Important
Boring	☐	☐	■	☐	Interesting
Fun	☐	☐	■	☐	Not fun
Easy	☐	☐	■	☐	Hard
Slow	⊡	■	☐	☐	Fast
Good at it	☐	☐	■	⊡	Not good at it

Each of these ratings expressed the responding teacher's view. Therefore it should be noted that the fourth category refers to teachers' perception of pupils' attitudes and not to measured attitudes of pupils themselves.

In Table 6 the position of the median teacher on each item and on each scale is represented by the blackened square. The modal position is indicated by a black dot in the appropriate square. Where only a blackened square is evident the median and the mode coincide. Means were not calculated, since that statistic is clearly inappropriate for scales of this type. This argument might also be advanced against the use of the median, although with far less force. In showing both the median and the mode it is possible to identify those scales on which the distribution of responses exhibits appreciable skewness as well as the direction of that skewness.

In Table 6 it may be seen that responding teachers showed the greatest unanimity and assurance in their ratings of essentially numerical activities, i.e., on items 1, 4, 5, 7, and 9. Conversely, they were least definite in their views about "related" activities, e.g., items 3, 11, and 12. They responded with no more than moderate self-assurance about their abilities in all activities save simple addition of whole numbers. Ratings also show a moderate to high lack of self-assurance about their ability to engage in activities that transcend even slightly the traditional mathematics curriculum of the elementary school, i.e., items 10, 11, and 12.

Teachers' opinions about issues and problems in the teaching of elementary mathematics are presented graphically in Table 7. Histograms next to each item are proportionate to the frequencies with which respondents chose that category of response. From an inspection of responses to items subsumed by the first question it is clear that teachers uniformly regarded all issues listed as of definite importance excepting perhaps the necessity for parents to have an understanding of "contemporary" mathematics. There is slightly less agreement about methods in teaching mathematics. Though, on the whole, there is fairly good agreement about them, there is a notable exception in the views of the value of drill and practice. A relatively large proportion of teachers also seem to have a slightly sceptical view of procedures outlined for them in manuals and guides. Perhaps surprisingly they agreed fairly well that assignment of homework is an only moderately successful procedure in teaching mathematics. Opinions are somewhat divided about what constitutes a problem in learning mathematics. Evidently, the ability to understand abstractions is regarded as essential while there is little agreement concerning the importance of interest in the topic. Similarly, there is no unanimity about problems in teaching mathematics. Consistent with responses under the previous question about learning, the matter of arousing students' interest in mathematics is not thought to be a very serious problem in teaching. Despite the uncertainty about problems in teaching and learning of mathematics, there is high agreement about factors in planning a mathematics curriculum. Each of the factors listed is quite uniformly regarded as being "very important." Finally, it is clear that the mathematics curricula taught by the teachers in this sample were quite similar. All of the "principles and practices" listed in Question 6 were responded to affirmatively by the overwhelming majority of the teachers. Four minor exceptions exist, i.e., g, j, k, and m, but in these cases, too, a decided majority stated that these topics are "definitely included." The IAS tends to suggest that the respondents are more confident in routine, "traditional" curricular settings than in less well-defined and familiar "unconventional" settings.

TABLE 7

TEACHERS' VIEWS OF ISSUES AND PROBLEMS IN TEACHING ELEMENTARY MATHEMATICS

1. What do you consider to be the most important issues or "controversies" in teaching mathematics and arithmetic in the elementary school today? Please indicate your answers by placing an "X" in one of the boxes at the right of each issue listed.

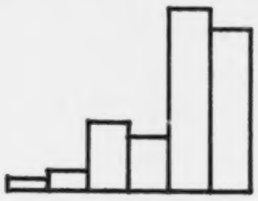
ISSUES

Not an important issue

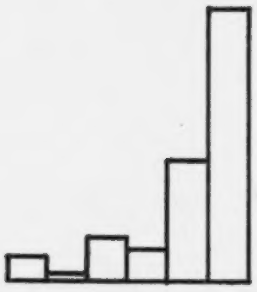
Of some importance as an issue

Definitely an important issue

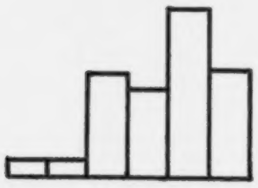
a. The effectiveness of ability grouping in math classes.



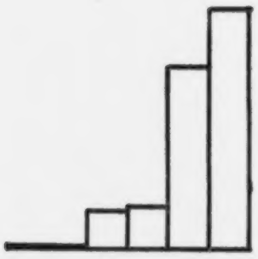
b. Standardization of vocabulary and language structure used in contemporary children's math texts.



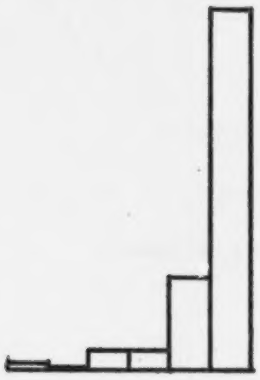
c. Parents' understanding concerning contemporary math instruction.



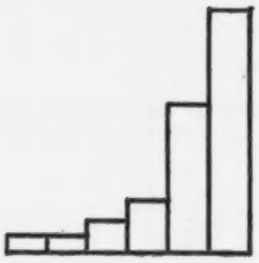
d. Approaches to teaching mathematics.



e. Continuity of math courses from primary grades through high school.



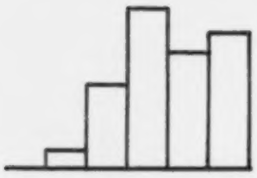
f. Defining the role of "new math" in the school curriculum.



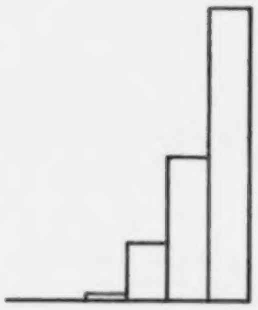
2. Which teaching methods do you find sucessful in teaching mathematics and arithmetic? Which are unsuccessful or less successful? Please indicate the degree of success you do enjoy or that you believe you might enjoy in teaching mathematics by placing an "X" in one of the boxes at the right of each method.

METHODS	Unsuccessful	"Average" success	Very successful

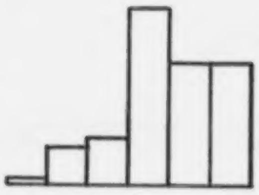
a. Drill and Practice



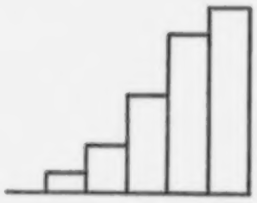
b. Concrete illustration or demonstrations of concepts



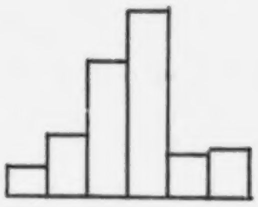
c. Following procedures outlined in teachers' manuals and guides



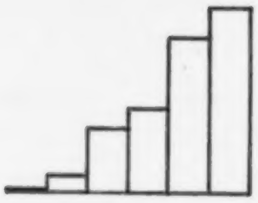
d. Providing individualized instruction



e. Assigning homework



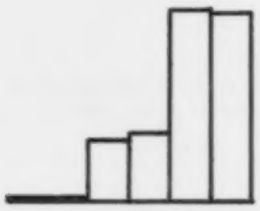
f. Providing opportunities for students to question principles and procedures



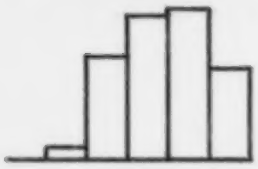
3. From your point of view, what are the problems for the student in learning mathematics and arithmetic? Please answer by placing an "X" in one of the boxes at the right of each problem.

PROBLEMS IN LEARNING	Definitely not a problem	A problem, but one of moderate consequence	Definitely a problem

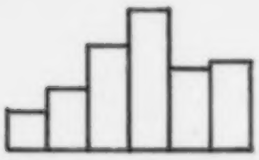
a. Ability to understand abstractions



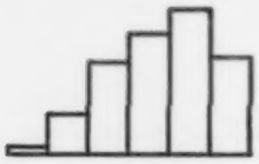
b. Semantics



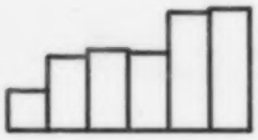
c. Quality of children's textbooks



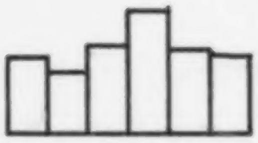
d. Facility with mathematics operations



e. Continuity of course content from grade-to-grade



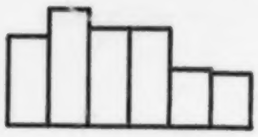
f. Children's interest in mathematics



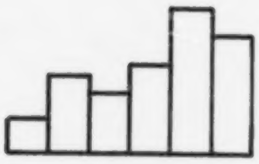
4. What do you see as problems in teaching mathematics and arithmetic? Please indicate your response by placing an "X" in one of the boxes at the right of each problem.

PROBLEMS IN TEACHING	Definitely not a problem	A problem, but one of moderate consequence	Definitely a problem

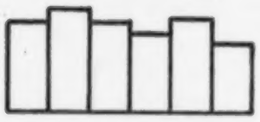
a. Arousing studentą' interest in math



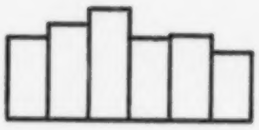
b. The teacher's own background and experience in mathematics



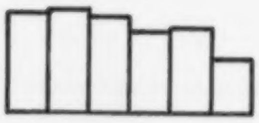
c. Accessibility of teacher inservice training programs



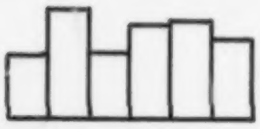
d. Accessibility of reference materials



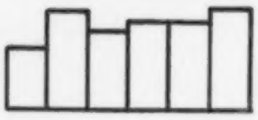
e. Quality of teachers' manuals



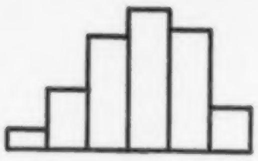
f. Quality of children's math textbooks



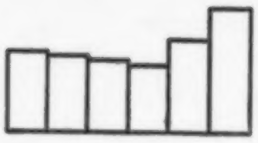
g. Class time available for actual teaching activities



h. Semantics



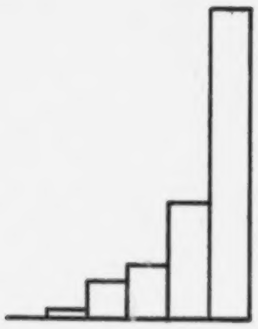
i. The teacher's own interest in math



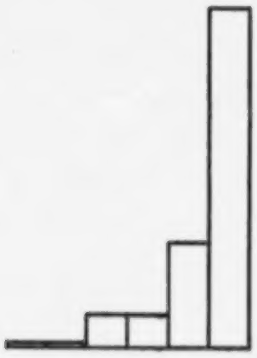
5. What factors do you think should be taken into consideration in planning a mathematics and arithmetic curriculum? Please indicate your answer by placing an "X" in one of the boxes at the right of each factor.

FACTORS	Does not need to be considered or not important	Should be considered as having importance	Needs very definite consideration or very important

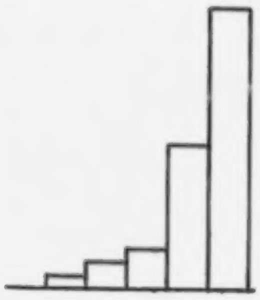
a. Relating mathematics to experiences familiar to the students



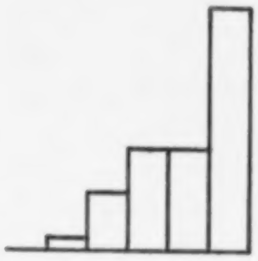
b. Helping children to understand the "how" and "why" of mathematical principles and operations



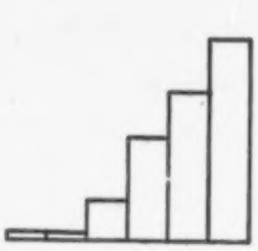
c. Continuity of concept development



d. Basic purposes of the math program

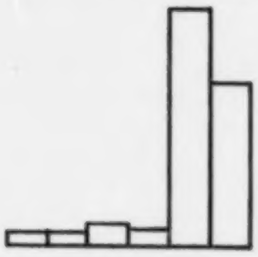


e. Development of quantitative relationships

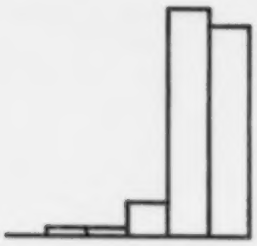


6. What mathematical principles and practices are included in the curriculum for the grade level(s) you teach? Please answer by placing an "X" in one of the boxes at the right of each group of principles and practices.

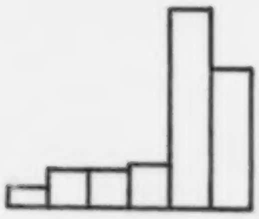
Definitely is not included — Optional inclusion — Definitely is included



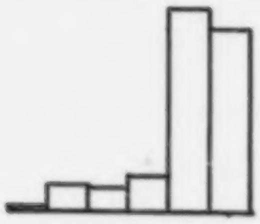
a. Mathematical structures



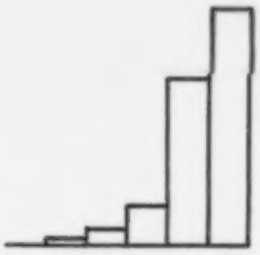
b. Providing mathematical experiences



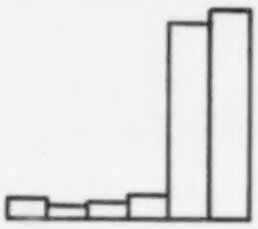
c. Mathematical systems



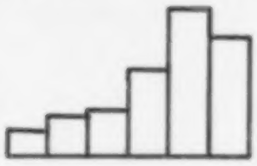
d. Concepts of real numbers



e. Number names

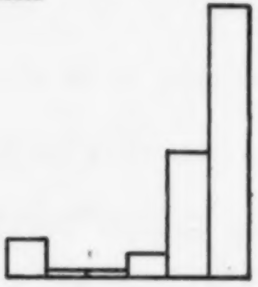


f. Operations on real numbers

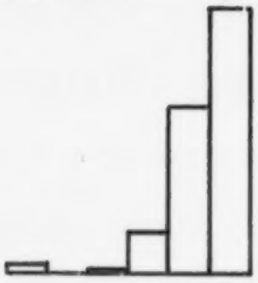


g. Writing story problems

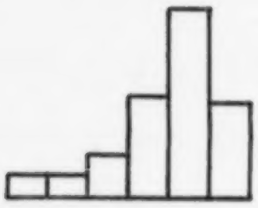
Definitely is not included
Optional inclusion
Definitely is included



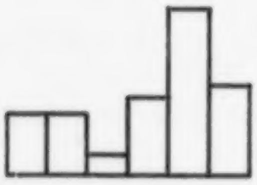
h. Operations in Base Ten



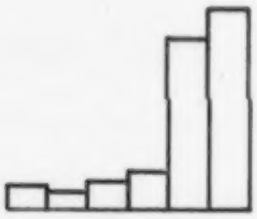
i. Problem Solving



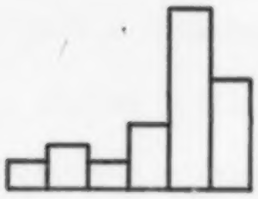
j. Working with abstractions



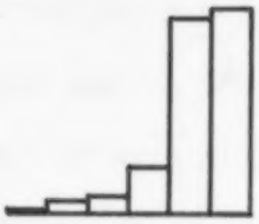
k. Applied number theory



l. Applied basic operations



m. Physically structuring the number system



n. Application of mathematics to everyday life situations

DISCUSSION

Before proceeding to a discussion of the results proper a brief explanation concerning pupil data will be in order. It will be recalled that the original plan of evaluation called for the testing of pupils of a selected sample of participating teachers both before and after the series of telecasts. These tests were, in fact, administered to pupils. However, two major difficulties militated against expending the efforts and funds for analyzing these data. The first of these difficulties is the lack of an appreciable learning gain by the teachers. In the absence of such gains, an examination of conditional, subsidiary hypotheses (see Introduction) is not warranted. Secondly, pupils in grades K through 3 were tested and retested with the same test forms, since alternate forms were not available. In the case of grades 4 through 8, though, alternate test forms of standard tests (STEP) were used; there was again no balanced split for the sequence in which forms were administered. Hence, measured results could not have been interpreted without crucial ambiguities. For these reasons, then, pupil data, though obtained largely as planned, were not analyzed.

In discussing the evaluation as it concerns the participating teachers, we must first consider a finding whose implications are prolegomenous to obtained results. This is the attrition factor that operated on participants and shrank the sample for which more or less complete data were ultimately obtained (pretest and posttest on one or more of the measures) to somewhere between 52% and 54% of the total sample of initial registrants. It is usual for studies of this type to experience some attrition among subjects, but rarely is the rate quite so high as in the present case. If the attrition factor operated selectively, the error that could be introduced thereby could be so great as to render obtained results totally unrepresentative. For example, if those teachers tended to drop out who experienced the greatest difficulties in mastering the subject-matter, or if only those dropped out who had the least difficulties and for that reason perhaps became bored, the mean achievement of the remaining group would be unduly inflated or depressed depending on whether the former or the latter possibility was the actual case. The amount by which the mean result might be artificially depressed (or inflated) would be practically negligible, if the attrition were about 1%. It would be far from negligible--quite the opposite--with an attrition exceeding 50%.

The problem of the time reliability and generality of findings, which in the present case unfortunately cannot be answered, hinges on the question of whether the attrition factor did operate selectively. We can only speculate on the basis of circumstantial evidence. Even a cursory inspection of test directions in Appendices A and B is sufficient to establish that each test administered, whether in the pretest and posttest group or whether in the series of Unit Tests, required a very considerable amount of time for its completion. This burden of time was imposed on the participating teachers over and above the time that they might have reasonably expected to devote to the viewing of the telecasts plus associated pilot center activities. There was no special compensation for any of these extra-classroom efforts. A teacher taking all of the pretests, posttests, and Unit Tests would have to invest as much as 10 hours in these probably distasteful tasks without compensation other than a tenuous gratitude of some vaguely identified professional colleagues. The prevailing attitude is pointedly expressed in the following excerpt from the letter of a cooperating principal to the project director: "The teachers seem to be a bit glum over the prospects of another three hours of testing--I'd recommend that we not do it if it's at all possible."

The situation was further aggravated by the teachers' mistrust of the investigators' integrity. There were repeated and clearcut indications that participating teachers did not believe assurances that their scores would be used solely for purposes of evaluating the telecasts and would remain anonymous. Apparently they misunderstood the intentions of the investigators, or totally disbelieved their assurances, suspecting that teachers rather than the telecasts were being evaluated. The suspicion seems to have been that scores would be reported to their supervising principals and that they would affect contract offers and pay raises for the next year. Under these circumstances the large attrition is plausibly accounted for, but little light is cast on whether there was or was not any selectivity. Follow-up investigations that might have cleared up this matter were precluded because of excessive costs.

Remembering these qualifications we can now turn to a consideration of obtained results. It has been pointed out previously that the absence of a provision for the order of test form administration in the research design of this evaluation makes it impossible to establish the presence or absence of order effects as well as making it impossible to estimate test form equivalence for participants. Although test form equivalence was established in the course of test standardization (see pp. 55-57 of Appendix A), this does not provide an ironclad guarantee that the forms were truly equivalent for the present sample of test takers. Once more we shall be forced to rely on circumstantial evidence.

In consulting Tables 28, 29, and 30 of Appendix A, we find, first of all, that in the case of the Cooperative Arithmetic Test the mean performance of participating teachers placed them well into the upper quartile when compared to 7th, 8th, and 9th graders on both national and urban norms. Assuming that 9th graders are more nearly comparable to teachers than 7th or 8th graders, we find that teachers' mean performance on the pretest as well as the posttest places them approximately at the 92nd percentile by national norms and at the 94th percentile by urban norms. Their position on the national norms is in a percentile band which is clearly superior to 85% of the tested 9th graders and clearly inferior to only 2% of them. This is true for standings on either test form. The suspicion cannot be dismissed that arithmetic skills of teachers had reached some plateau or asymptotic limit before telecasts began so that the skills measured by the instrument in question could not show further improvement. The suspicion is strengthened when we recall that in the IAS teachers exhibited the greatest self-assurance with respect to their ability to do numerical or simple arithmetical tasks. Indeed, it would seem that arithmetic is so much a part of life in the elementary classroom that the degree of practice thereby entailed would likely mask or submerge any practice effects of 15 thirty-minute telecasts.

A somewhat different picture emerges with respect to the Cooperative Structure of the Number System Test. Here the teachers' mean performance on the pretest placed them superior to only 18% of 8th graders on national norms and clearly inferior to no less than 48% of them. Obviously this is not a very impressive performance. It leaves considerable room for improvement. In fact, performance on the posttest shifted teachers' mean position slightly upward so that they were now clearly superior to 31% of the 8th graders, but still clearly inferior to 57% of them. In absolute terms this is an almost negligible improvement regardless of the statistical significance (reliability) of the obtained differences. While these differences do exist undeniably, there is reason to believe that they may have arisen spuriously, or that they might not be an effect of the telecasts alone. Since we have no information (and cannot obtain it) as to how a group of comparable teachers might have performed who would have taken the pretest and the posttest, but would not have viewed the telecasts, we cannot assess the sheer effect of pretest practice on posttest performance. In short, the obtained improvement might have arisen purely as a result of experience in taking the SNS test.

We must next examine the surprising and somewhat confusing results obtained with the Insightful Arithmetic Test. How are we to interpret a small, but statistically significant gain with one group in the face of an equally large, equally significant loss with another group? First, it is obvious that the absolute size of both gain and loss is so small as to render them of no practical significance. Even if the loss in score had not occurred, a gain so small resulting from a major instructional effort such as the series of telecasts must surely be regarded as highly disappointing. There is reason to believe, however, that both the gain and the loss were purely spurious. It will be recalled that the IAT unlike the other tests used was a specially constructed one which, in its assembled form, had not been standardized. Though data did exist about the characteristics of each of the items used in the test, and though alternate test forms were assembled so as to maximize the likelihood that they would subsequently prove to be equivalent, these assumptions were not subjected to empirical verification. Fortunately, in the case of this test we, can approximately assess the effect of "order of administration." Only an approximate assessment is possible, since the order of test form administration was not randomized across all participants but remained inextricably confounded with locations. Nonetheless we find most saliently that one order of test administration yields a gain in number of items answered correctly, while the other order yields a loss of approximately equal size. These results can be most easily accounted for by assuming that one test form (LTTIZ 4) was of greater mean difficulty than the other (KLTTIZ 2). Presumably the telecasts produced no tangible effect on mathematical capabilities assayed by the IAT. Note, in this connection, that the Englewood, N. J. group, which showed the loss, was also the one that was posttested sooner after the end of the telecasts than the rest. Hence, there was less opportunity for forgetting to occur, and a more substantial gain than for the rest of the groups rather than a loss might have been expected.

Overall the present findings lend themselves to two major interpretations. Either the teachers did not benefit from viewing the series of telecasts in accordance with a priori expectations, or the tests used in the evaluation did not measure those variables on which a change did occur. An explanation in terms of a combination of both these reasons is also possible. The results of the Unit Tests do suggest that the teachers did not benefit greatly from the televised instruction. Their mean performance on the Unit Tests ranges from a low of 42% correct responses on UN-1 to a high of 57% correct responses on UN-4. In the latter case, however, the sample from which the results were obtained is much attenuated. In contradistinction to the Cooperative tests and the IAT the items in the Unit Tests were taken directly from the scripts of the telecasts. Thus there can be little doubt about their relevance and test "difficulty" must be viewed as inadequate mastery of the subject matter rather than as an inherent limitation in the examinees' capacities. Certainly the pattern of results with the Unit Tests tends to corroborate the findings with pretests and posttests. If the latter failed to register some obscure changes that did occur, it must be remembered that their pertinence was established by prior agreement and that any unmeasured changes that might have occurred can have no relevance for this evaluation.

The generality of the findings is limited, of course, due to the attrition factor mentioned earlier. It is further limited by the lack of precise control over conditions of utilization. Present measurements cannot separate the effects of the telecasts per se from the conditions under which they were viewed, reviewed, and supplemented by independent study. Not only was control over these utilization conditions lacking, but even complete and reliable information was unavailable.

A summary implication emerges from the present evaluation effort. Scientific methodology as well as technological methodology ordain that design, development, and evaluation must always be planned and carried out integrally. Had it been possible to follow such a procedure in the present case, less ambiguous evaluation results and a more effective product (telecast tapes) would very likely have resulted. If evaluation issues had been faced at the very inception of the overall project, many of the present research design problems could have been provided for or circumvented. If the design of each telecast as well as of the series as a whole had drawn upon established research findings and on the techniques of modern applied science, an optimal solution for the problem, or the purpose in providing this instruction, might have been found. If a systematic development procedure had been followed (with frequent empirical checks) inadequacies could have been diagnosed and corrected early until some minimal, specified instructional effectiveness for the product had been assured.

A corollary implication emerges for the economics of this type of situation. At the outset of the present report it was explained that economic considerations had to override scientific considerations in the present case in order to keep the costs of their evaluation from dwarfing the costs of producing the telecasts themselves. These lopsided economics are not immutable, but are engendered by post hoc decisions to evaluate an already fixed plan. Had it been possible to plan all evaluation procedures together with the telecasts, a major portion of the evaluation procedures could have been carried out concurrently with telecast development and on a small, relatively inexpensive scale. A subsequent field-test would still have been necessary but could have been planned more rigorously, more efficiently, and at far less expense. An integral program of design, development, and evaluation admittedly would require greater expenditures than a straightforward development alone, but the increment would not be so disproportionately large as in the case of a post hoc evaluation. This larger total cost must be weighed against the consideration that recorded instruction (e.g., telecast tapes, films, programed texts), once it has been rendered effective, continues to be effective and its costs can be distributed over a very great many students in the course of extended re-uses. It would appear to be a false economy to jeopardize the attainment of proven effectiveness by saving on development costs of instructional materials only to be forced into discarding them quickly, because they do not produce the desired learning effects.

References

Boisclair, Elizabeth. The set of natural numbers. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program I, mimeographed.) (a)

Boisclair, Elizabeth. Operations. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program II, mimeographed.) (b)

Boisclair, Elizabeth. More on operations. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program III, mimeographed.) (c)

Boisclair, Elizabeth. Numerals. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program IV, mimeographed.) (d)

Boisclair, Elizabeth. More on numerals. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program V, mimeographed.) (e)

Boisclair, Elizabeth. Algorisms. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program VI, mimeographed.) (f)

Boisclair, Elizabeth. More on algorisms. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program VII, mimeographed.) (g)

Boisclair, Elizabeth. How or why? (a review). Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program VIII, mimeographed.) (h)

Boisclair, Elizabeth. Sets of integers. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program IX, mimeographed.) (i)

Boisclair, Elizabeth. Arithmetic numbers. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program X, mimeographed.) (j)

Boisclair, Elizabeth. Decimal fractions. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program XI, mimeographed.) (k)

Boisclair, Elizabeth. Rational numbers. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program XII, mimeographed.) (l)

Boisclair, Elizabeth. Finite systems. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program XIII, mimeographed.) (m)

Boisclair, Elizabeth. Points in space. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program XIV, mimeographed.) (n)

Boisclair, Elizabeth. Numbers and points. Sets and systems. Teachers' Guide. Cambridge, Mass.: Eastern Educational Network, 1963. (Program XV, mimeographed.) (o)

College Entrance Examination Board. Technical manual for users of test analyses. Princeton, New Jersey: Educational Testing Service, November 1956.

Mills, D. F. Evaluation of an in-service training program in mathematics for elementary teachers by television. A project designed to evaluate the effectiveness of the Northeastern Regional Instructional Television Library Project. Progress Report No. 2 and Research Memorandum 64-10. Princeton, New Jersey: Educational Testing Service, 1964.

Myers, S. S. Questions illustrating the kinds of thinking required in current mathematics tests. Princeton, New Jersey: Educational Testing Service, June 1, 1964. (Unpublished manuscript.)

Northeastern Regional Instructional Television Library Project (M. V. Biggy, Director). Sets and systems. Television programs. Cambridge, Mass.: Eastern Educational Network, 1963. (Video tape.)

APPENDIX A

COOPERATIVE MATHEMATICS TESTS

DIRECTIONS FOR ADMINISTERING

Note: Instructions which are to be read aloud to students are printed in **bold** type. Instructions printed in regular type are intended *only* for the examiner. Directions are appropriate for all tests and forms.

In these Directions and in the test booklets the students are instructed to make their marks heavy and black. This is desirable for IBM 805 answer sheets or for hand-scoring. It may not be advisable, however, with other types of scoring machine. It is suggested, therefore, that you consult the person responsible for scoring (or the manufacturer of your machine), and modify this instruction if necessary.

When the students are assembled in the examination room and seated, say:

The testing period has begun. There will be no talking among you until after you have been dismissed.

We shall now pass out test materials. Do not open your booklet or turn it over until you are told to do so.

Distribute booklets with answer sheets, scratch paper, and pencils. Instruct the students to enter all the information you require on the answer sheet—name, school, test form, etc. Check that each student is working on the correct side of the answer sheet.

Then say:

Read the General Directions on the front cover of your test booklet silently as I read them aloud.

GENERAL DIRECTIONS

Choose the appropriate first sentence:

This is a 40-minute test.

Or:

This test has two 40-minute parts.

Then proceed:

Do not spend too much time on any one question. If a question seems to be too difficult, make the most careful guess you can, rather than waste time over it. Do not worry if you do not finish the test. Your score is the number of correct answers you mark.

Use scratch paper to work problems. Do not make any marks in your test booklet.

Mark all answers on the separate answer sheet. Make your answer marks heavy and black. Mark only one answer for each question. If you make a mistake or wish to change an answer, be sure to erase your first choice completely.

Note how the answer to the EXAMPLE is marked on your answer sheet.

(Note: Since the example given for each test title is different, the examiner may want to fill in the appropriate example in the space provided below. This information may be copied from a test booklet. If desired, the example may be written on the chalkboard.

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Check to make sure that students have located the example on their answer sheets.

If you are administering Part I of a two-part test, say:

Work only on Part I. Do NOT go on to Part II until you are told to.

When I say "Begin," open your test booklet and start to work. Ready? Begin!

Examiners and proctors (if any) should move quietly about the room to see that each student is working on the proper part of his test booklet and answer sheet. At the end of *exactly* 40 minutes say:

STOP! Even if you have not finished, you must stop and lay down your pencil.

If only a one-part test is being given, collect answer sheets, test booklets, and other test materials. Then dismiss students.

If both parts of a two-part test are being given in one session, allow a short break at this time.

If a two-part test is being administered in two sessions, collect answer sheets, test booklets, and other test materials. Then dismiss the students.

When the students are ready to begin Part II, say:

When I say "Begin," open your test booklets to Part II and start to work. Ready? Begin!

If there has been a considerable lapse of time between the testing sessions, review the General Directions before giving the instruction above.

Again, examiners and proctors should move quietly about the room to see that each student is working on the proper part of his test booklet and answer sheet. At the end of *exactly* 40 minutes say:

STOP! Even if you have not finished, you must stop and lay down your pencil.

Collect answer sheets, test booklets, and other test materials. Then dismiss the students.

At the end of any testing session, you should write down a description of any unexpected variation from the normal testing procedure that may have occurred. Such incidents should be in the record to be considered when scores are interpreted.

HANDBOOK

COOPERATIVE MATHEMATICS TESTS

EDUCATIONAL TESTING SERVICE, PRINCETON, N.J. • BERKELEY 4, CALIF.

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- **THE DIRECTIONS FOR ADMINISTERING AND SCORING CONTAINED IN THIS PUBLICATION ARE SUITABLE FOR USE WITH ALL FORMS OF THE COOPERATIVE MATHEMATICS TESTS.**

INTRODUCTION

Alternate forms of the same mathematics test may be administered simultaneously in one group—one part of the group may take Form A of Arithmetic, for example, while another part of the group is taking Form B, Arithmetic. Directions and timing for all forms of one test are identical.

The tests in this series have either one or two parts. For instance, each form of Arithmetic consists of one part requiring 40 minutes of testing time. Geometry, however, consists of two 40-minute parts in one test booklet. These parts may be administered in separate sessions.

PREPARATIONS FOR TESTING

What materials should be assembled before testing?

The following should be used as a check list by the examiner in determining that all necessary materials are available several days *before* any students are to be tested:

1. As many test booklets as the number of students to be tested—allow a few extra for emergencies.
2. As many answer documents as the number of students to be tested—allow a few extra for emergencies. Be sure that the answer documents used are compatible with the scoring method planned. Apart from the more familiar IBM answer sheets, there are many other answer sheets and answer cards in use for various types of machine scoring. Throughout these directions we will use the term "answer sheet."
3. A copy of this publication for each examiner.
4. Pencils compatible with the scoring method planned. Students should not use ink.
5. A timer—any watch or clock, or an automatic timer.
6. A notebook or paper on which the examiner can record exact starting and stopping times and make any relevant notes during and after testing.
7. A supply of scratch paper—at least two sheets for each student.

What are the necessary arrangements to make before testing?

Smooth test administration results when preliminary planning is done with care. Examiners should consider each of the following points *before* students are tested:

1. *Study of test materials.* Read and become thoroughly acquainted with the materials to be used: test booklets, answer sheets, and the directions in this booklet.
2. *Practice administration.* Give the test to another teacher, a friend, or a group of students not to be included in the regular administration. Follow directions and timing exactly.
3. *Advance announcement to students.* Announce the forthcoming test and answer legitimate questions about what the testing will involve. Do not keep students "in the dark." On the other hand, do not overemphasize the approaching test date.
4. *Time scheduling.* Allow 45 minutes for a single test or one part of a two-part test; 90 to 95 minutes for a two-part test to be given in one session.
5. *Room scheduling.* Conduct testing in a room that does not crowd examinees. Select a testing place with good lighting and ventilation and freedom from noise and interruption.

Time Allowances (min.)

	One 40-min. Test	Two-part Tests		
		One Session	Two Sessions	
			1st Session	2nd Session
Distributing materials	3	3		
General Directions	2	2		
Testing Time	40	40		
Recess		5		
Distributing materials				3
General Directions		2		2
Testing Time		40		40
TOTALS	45	92	45	45

6. *Seat and desk arrangements.* Seat students so that they will not be tempted to look at the answers of others and so that the examiner can go to a student who has a question about directions without disturbing other students. If possible, use an alternate row arrangement with students directly behind one another in every other row.
7. *Arranging test materials.* Insert an answer sheet and scratch paper in each test booklet. Immediately prior to testing, stack booklets and other materials in the testing room.
8. *Arranging for proctors.* If you are testing more than 30 or 40 students, you will need assistants or proctors. You should brief these people on the test materials and testing procedures and carefully specify their jobs before, during, and after testing. They will help to distribute and collect test materials, observe students from different points in the room while the test is being taken, and respond quietly when a student indicates that he is having trouble following directions. Assign proctors specific room areas to "cover" during testing to prevent either overlap or neglect of some students.
9. *Information on students.* You may wish the students to record additional information on their answer sheets. Before testing, decide whether additional information is desired and include this step in the directions on p. 4.

What is the role of the examiner during testing sessions?

1. The examiner should establish and maintain a quiet working atmosphere.
2. The examiner is responsible for reading all directions to students carefully, *word for word.*
3. In answering questions raised by students, the examiner should stay within the meaning and, as far as possible, the exact wording of the printed directions. Questions about guessing should always be answered by reading this sentence from the General Directions: "If a question seems to be too difficult, make the most careful guess you can, rather than waste time over it."
4. Keep distractions to a minimum. The examiner and proctors should not talk or whisper to each other while testing is going on. When enforcing order, an examiner should be careful not to create a general disturbance.
5. Timing must be carried out exactly; under no circumstances is additional time to be allowed.

What special procedures apply to two-part tests?

If both parts of a two-part test are given in one session, allow a 5-minute recess between the first and second parts. See Procedure B, p. 6.

1. At the end of the first part, instruct students to turn their answer sheets over on their desks so that the unused side is exposed.
2. During the recess, students may stand by their seats and relax.
3. When the recess is over, the students should be called to order and seated in their original places. Follow Procedure B, p. 6.

If a two-part test is given in two sessions, see Procedure C, p. 6. Arrange for each student to get back his own answer sheet at the second session. If the group is small the examiner may distribute answer sheets, one at a time, by name. Use one of the following methods for larger groups:

1. At the end of the first session collect answer sheets by rows. Instruct students to sit in the same seats at the second session. Distribute answer sheets by rows.
2. Sort answer sheets from the first session on a table in small piles according to the first letter of students' last names. Label each group with a placard reading "A to E," "F to K," etc. As students enter the room for the second session, they can pick out their answer sheets from the appropriate pile. Booklets for the second session are distributed as indicated in the directions for administering.

DIRECTIONS FOR ADMINISTERING

Note: Instructions which are to be read aloud to students are printed in bold type. Instructions printed in regular type are intended *only* for the examiner.

When the students are assembled in the examination room and seated, say:

The testing period has begun. There will be no talking among you until after you have been dismissed.

We shall now pass out test materials. Do not open your booklet or turn it over until you are told to do so.

Distribute booklets with answer sheets, scratch paper, and pencils. Instruct the students to enter all the information you require on the answer sheet—name, school, test form, etc. Use this box to record these items as a reminder during the administration.

Answer sheet information

Allow time for this and check to see that students have filled in the correct information.

If special pencils are required

If special pencils are required for machine scoring, say:

You have been given a special pencil. Use it in marking your answers; otherwise, your answers will not score properly.

Then say:

Read the General Directions on the front cover of your test booklet silently as I read them aloud.

GENERAL DIRECTIONS

Choose the appropriate first sentence:

This is a 40-minute test.

Or:

This test has two 40-minute parts.

Then proceed:

Do not spend too much time on any one question. If a question seems to be too difficult, make the most careful guess you can, rather than waste time over it. Do not worry if you do not finish the test. Your score is the number of correct answers you mark.

Use scratch paper to work problems. Do not make any marks in your test booklet.

Mark all answers on the separate answer sheet. Make your answer marks heavy and black. Mark only one answer for each question. If you make a mistake or wish to change an answer, be sure to erase your first choice completely.

Note how the answer to the EXAMPLE is marked on your answer sheet.

(Note: Since the example given for each test title is different, the examiner may want to fill in the appropriate example in the space provided below. This information may be copied from a test booklet. If desired, the example may be written on the chalkboard.)

Check to make sure that students have located the example on their answer sheets.

> If you are administering Part I of a two-part test, say:
>
> **Work only on Part I. Do NOT go on to Part II until you are told to.**

Choose the appropriate sentence:

When I say "Begin," open your test booklet and begin to work.

Or:

When I say "Begin," open your test booklet to Part II and begin to work.

Then proceed:

Ready? Begin!

Examiners and proctors (if any) should move quietly about the room to see that each student is working on the proper pages of his test booklet and that he is marking his answers correctly in the proper section of his answer sheet. At the end of *exactly* 40 minutes say:

STOP! Even if you have not finished, you must stop and lay down your pencil.

Choose the one of the three following procedures which is appropriate:

Procedure A to follow at **end of testing program** (after one test, if only one test is given; or after the second part, if a two-part test is given)

Collect answer sheets first and then test booklets and all scratch paper. Count the test booklets before permitting students to leave, and check the count against the number of booklets you should have. If pencils were supplied, instruct students to hand them to you (or a proctor) as they leave.

At this time, you should write down a description of any unexpected variation from the normal testing procedure that may have occurred. Such incidents should be in the record to be considered when scores are interpreted.

Procedure B: after the first part of a two-part test—if given in one session

Say:

Close your test booklet. Turn your answer sheet over to the unused side.

Allow students to stand and relax by their seats for about 5 minutes. Booklets should remain closed on the students' desks. At the end of the rest period, the students should be called to order and seated in their original places. Testing may then continue with Part II, ending with Procedure A, above.

Procedure C: after the first part of a two-part test—if given in two sessions

Collect answer sheets first and then test booklets and all scratch paper. Count the test booklets before permitting students to leave, and check the count against the number of booklets you should have. If pencils were supplied, instruct students to hand them to you (or a proctor) as they leave.

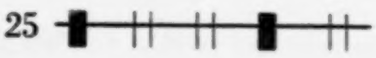
At this time, you should write down a description of any unexpected variation from the normal testing procedure that may have occurred. Such incidents should be in the record to be considered when scores are interpreted.

When students return for the second session, distribute test booklets and pencils as before. Redistribute answer sheets as suggested on p. 4 of this publication. Ask students to make sure that they have their own answer sheets. Then proceed with Part II, ending with Procedure A, above.

DIRECTIONS FOR SCORING

How do you score by hand?

1. Assemble the answer sheets, sorted by test title and form if you administered more than one, together with appropriately punched stencils.
2. If a student has clearly marked more than one answer to a question, draw a colored line through all of his answers, thus:



   If the student has partially erased one choice, and it is clear that he intends another marked choice as his answer, do not mark through the item. Instead, erase completely the "extra" marking.
3. Count and record the number right on each answer sheet. This is the raw score.
4. Check your work by having the answer sheets re-scored by another person, if possible.
5. Turn to the section on Preparations for Interpreting Scores to determine whether you should work with raw scores or converted scores. Follow the procedure suggested there.

How do you score by machine?

Follow the procedures recommended for the particular machine you are using.

MANUAL

DESCRIPTION OF THE COOPERATIVE MATHEMATICS TESTS

What do the Cooperative Mathematics Tests measure?

The Cooperative Mathematics Tests measure achievement in the major content areas of mathematics from junior high school arithmetic through calculus. Achievement is assessed in terms of students' comprehension of the basic concepts, techniques, and unifying principles in each content area. Where possible, many of the newer trends and emphases in mathematics are represented in the tests, but content has been selected carefully to ensure the appropriateness of the tests for most students. Ability to apply understanding of mathematical ideas to new situations and to reason with insight are emphasized. Factual recall and computation are minimized.

How is the Cooperative Mathematics Series organized?

The Cooperative Mathematics series is readily adaptable to most mathematics curricula. At the junior high school level, the series includes tests in both Arithmetic and Structure of the Number System. The Arithmetic test stresses understanding and application of mathematical principles embodied in arithmetic, as opposed to "consumer" arithmetic, and is appropriate for classes in either traditional or modern mathematics. The Structure of the Number System test is designed primarily for classes in modern mathematics. Three algebra tests in the series, designated I, II, and III, correspond approximately to courses frequently termed "elementary," "intermediate," and "college" algebra. The Algebra III test is also appropriate for the algebra portions of courses in elementary college mathematics. Many concepts introduced in a lower level algebra test are developed further in a higher level test.

The Geometry test has two parts and can be administered in either a long or short version. Part I may be given alone to survey the important outcomes of a typical high school geometry course. Or, the total test may be given to provide a more thorough treatment of the concepts tested in Part I, plus applications of geometry in three-dimensional space. It is recommended that the longer, more reliable total Geometry test be administered whenever it is appropriate.

TABLE 1. Cooperative Mathematics Series

Test	Forms	Items	Time (min.)	Scores	Appropriate Groups
Arithmetic	A, B, C	50	40	Total	Grades 7, 8, 9
Structure of the Number System	A, B	40	40	Total	Modern mathematics classes: Grades 7, 8
Algebra I	A, B	40	40	Total	Grades 8, 9
Algebra II	A, B	40	40	Total	High School
Geometry	A, B	Part I—40 Part II—40 Total 80	40 40 80	Part I and Total	High School
Trigonometry	A, B	40	40	Total	High School, College
Algebra III	A, B	40	40	Total	High School, College
Analytic Geometry	A, B	35	40	Total	High School, College
Calculus	A, B	Part I—30 Part II—30 Total 60	40 40 80	Total	High School, College

The Trigonometry test and the Analytic Geometry test cover the work commonly included in separate one-semester high school or college courses in these subjects or in integrated courses in elementary college mathematics. The two-part Calculus test is designed to cover work in analytic geometry and calculus through differential and integral calculus of algebraic and transcendental functions, and includes work on topics such as the theorem of the mean and limits of indeterminate forms. About four-fifths of the test is devoted to calculus and one-fifth to analytic geometry. The test is appropriate for students who have completed work in separate courses in these content areas or at least a full year of work in these combined areas.

The content coverage and relative emphases of the tests are shown in detail in Tables 9-27, where all of the items in the tests are classified according to appropriate topical headings. Prospective test users will find the tables useful in judging the appropriateness of the tests for their purposes.

How do the Cooperative Mathematics Tests measure?

The Cooperative Mathematics Tests utilize five-choice items. Separate answer sheets for hand or machine scoring may be used with all tests in the series. The administration time for each test or test part is 40 minutes and directions for the tests are uniform, making it possible to administer two or more different tests within a group simultaneously. (Both the Geometry and Calculus tests have two separately-timed, 40-minute parts.)

All Cooperative Mathematics Tests yield a raw total score obtained by counting the number of correct responses. Separate scores for Part I of the Geometry test may also be obtained. The Calculus test yields a single total score for Parts I and II combined.

Instructions for administering and scoring the tests are given in the publication, *Directions for Administering and Scoring Cooperative Mathematics Tests.*

Scores on the Cooperative Mathematics Tests are interpreted by comparing them with scores for appropriate reference groups of students by means of norms tables. See the discussion beginning on page 11 of this *Handbook*.

How are the Cooperative Mathematics Tests useful?

Two kinds of test information are useful: test *scores* and *responses* to separate items or sets of items.

Ways in which test *scores* for individuals can be used include the following:

1. Assessing the achievement level of a student in relation to specified reference groups.
2. Identifying a student whose mathematics achievement is exceptionally high or low.
3. Comparing a student's mathematics achievement with his performance in mathematics courses and other courses requiring application of mathematics.
4. Giving parents a realistic, meaningful estimate of a student's developed proficiency in mathematics.
5. Helping a student and his parents to consider the student's present mathematics proficiency in relation to academic and vocational plans.
6. Suggesting a level of instruction which is appropriate for an individual student.
7. Grouping students of similar levels of proficiency for some instructional purposes.

Ways in which test scores for groups of students, classes, or larger school groups can be used include the following:

1. Appraising average levels of achievement for evaluating instructional programs. Alternate forms of a test can be used before and after instruction to evaluate outcomes.
2. Appraising average levels and ranges of achievement for instructional planning.
3. Conducting educational research where independent measures of mathematics achievement for a group or groups are necessary experimental "controls."

Many of these uses of test scores are illustrated in the section on interpreting test scores.

Information obtained from students' responses to separate items or sets of items is useful primarily for curriculum evaluation and planning and for instruction.

Ways in which item information can be used for curriculum evaluation include the following:

1. Obtaining an indication of the extent to which specific goals of the mathematics program are being achieved.
2. Comparing the performance of the local student group in specific content and skill areas with that of students nationally.
3. Identifying topics in which the local student group is exceptionally high or low in relation to local goals or the performance of students nationally.

Ways in which item information may be used for instruction include the following:

1. Comparing the performance of a class group in specific content and skill areas with other classes, all of the students locally, or students nationally.
2. Identifying topics that are troublesome for a class or for individual students.
3. Discovering the kinds of errors that students make.
4. Grouping students for special instruction.

The item content classifications, Tables 9-27, are presented as an aid to working with test items. (See the section, Using Item Information.)

PREPARATIONS FOR INTERPRETING SCORES

Where does interpretation begin?

The norms tables for the Cooperative Mathematics Tests contain the information needed to translate raw scores into meaningful interpretations. The nature of this information should be clear to the test interpreter before he proceeds.

In general, a norms table lists all of the scores a clearly-defined group of students (called a norms group) earned on a test. For each score, the percentage of the students in the norms group that earned scores *lower* than that score are listed. These percentages are called percentile ranks. If a score has a percentile rank of 60, then, this means that 60 per cent of the students in the norms group earned scores lower than that score. Similarly, 40 per cent of the scores for this group were higher.

The norms tables for the Cooperative Mathematics Tests list two kinds of scores, raw and converted, and express percentile ranks in two ways—as mid-percentile ranks and as percentile bands.

Raw scores are simply the numbers of correct responses on a particular form of the test. Raw scores earned on different forms of a test are not directly comparable, because no two forms of a test are identical in content and difficulty. For this reason, raw scores on alternate forms of a test, such as Forms A, B, and C of Arithmetic, have been equated statistically and converted to a common score scale so that scores on all three forms of the test are comparable. The three-digit scores on this scale are referred to as *converted scores.*

The following example shows how the score columns in the norms table are arranged and read:

Raw Score		Converted Score
Form A	Form B	
50 - 51	51,52 - 53	160 - 161
-		
-		
-		
-		
19 - 20	19 - 20	130 - 131
17 - 18	18	128 - 129
15 - 16	16 - 17	126 - 127
14	14 - 15	124 - 125

For Form A, a raw score of 50 converts to 160 and 51 converts to 161. For Form B, both 51 and 52 convert to 160, and 53 converts to 161. For Form A, 14 converts to 124 and 15 converts to 126; no raw score on Form A converts to 125. Similarly, on Form B, no raw score converts to 128.

All data in the norms tables describing the performance of the norms groups (and all examples of score interpretation) in this *Handbook* are based on converted scores and apply regardless of the form of the test that has been administered. Only *converted* scores can be used to compare scores on different forms of a test or to compare scores on earlier Cooperative Mathematics tests with scores on the present tests. Where only one form of a test is administered, however, and no comparisons of performance on different tests or forms are desired, the test interpreter can work directly with raw scores.

The norms tables list the scores in two-score intervals. The *mid-percentile rank* is simply the percentile rank of the mid-point of the score interval, and the rank applies to both scores in the interval. Thus, for the national norms group for Arithmetic, grade 7 (Table 28), the mid-percentile rank of a score of 150 or 151 is 70.

Percentile bands are incorporated in Cooperative test manuals to help the test interpreter avoid the pitfall of placing unwarranted confidence in the precision of a single test score. Any test score is an *estimate* of the student's ability. If the student could take the test or different forms of the test many times, a range of scores or estimates would result. The assumption that any one of these scores is an exact measure of the student's ability is not justified. It is far safer to assume that the "true" measure of the student's ability lies within this range of scores than it is to place confidence in a single score. Percentile bands are constructed to take this probable range of scores into account and to increase the likelihood that interpretations based on test scores will be correct. For a score with a percentile rank of 60, the corresponding percentile band might be 50-70. If the test interpreter assumes that the student's actual standing in relation to the norms group lies between the 50th percentile and the 70th percentile, the chances are 2 to 1 that he is correct because the percentile bands are defined so as to provide this degree of likelihood.

Thus, when the test interpreter concludes that this student is in the third quarter of the group for this test, he can describe the limits (percentile band) within which he is basing his interpretations, and state the degree of confidence he can have that his interpretations are correct.

Which norms table is appropriate?

For any given test, a norms table might be developed for a representative sample of all students in the nation, all students in a school system, all students in a certain curriculum, or any other clearly definable group for whom the test is appropriate. Just as the level of performance of these groups might be expected to differ, so would the interpretations based on

TABLE 2. Publisher's Norms for the Cooperative Mathematics Tests

Test	School		College			
	National	Urban	National	Education	Engineering	Liberal Arts
Arithmetic						
Grade 7	*	*				
Grade 8	*	*				
Grade 9	*	*				
Structure of the Number System						
Grade 7	*					
Grade 8	*					
Algebra I						
Grade 8	*	*				
Grade 9	*	*				
Algebra II	*	*				
Geometry, Part I	*	*				
Geometry, Total	*	*				
Trigonometry	*	*	*	*	*	*
Algebra III	*		*	*	*	*
Analytic Geometry	*		*	*	*	*
Calculus	*		*	*	*	*

them; that is, a student with a given score would probably rank differently in comparison with each of these groups. Because test interpretations relate directly to the group on which the norms are developed, it is essential that the characteristics of the norms group be clearly stated, and that the test interpreter select a norms table carefully, with the purposes of the test administration and the intended uses of the test results clearly in mind.

The norms developed by the publisher for the Cooperative Mathematics Tests are listed in Table 2.

National norms are presented for appropriate grade, school, or college levels for all tests in the series. Where separate grade levels are not designated, the norms are for students in the appropriate high school or college courses regardless of grade level.

The national school norms are based on representative samples of students in public, Roman Catholic, and independent schools. The urban norms are based on national samples of students in public and Catholic schools in cities with a population of 100,000 or more.

Only students enrolled in special programs in modern mathematics, such as the School Mathematics Study Group program, were tested to establish the norms for the Structure of the Number System test. The grade 7 norms are for students who have completed the equivalent of one year of modern mathematics at the 7th-grade level. The grade 8 norms are for students who have completed the equivalent of two years of modern mathematics in grades 7 and 8.

The national college norms are based on samples of students in all major fields of study. Since students in three major fields of study—Education, Engineering, and Liberal Arts—constitute large proportions of the total group, separate norms are also presented for these sub-groups. Thus, the Calculus score of a student majoring in Education, for example, may be compared to the scores of all college students in the national norms group or of all Education majors in the national norms group.

The test administrations to establish norms for Cooperative Mathematics Tests were conducted in the spring, as students were nearing completion of the appropriate course work. If the tests are to be used in conjunction with courses in integrated mathematics which combine the content of two or more traditionally organized courses, a decision regarding the best time to administer the tests must be made. In general, if the publisher's norms are to be used, it is advisable to administer a test when the portion of the course to which the test applies is nearing completion, allowing a week or more in which test results can be used to help guide review.

MEANINGFUL INTERPRETATIONS

How do you compare a student's performance with that of students in a norms group?

Barbara Grant, a 9th-grade student, earned a converted score of 160 (raw score 29, Form A) on the Algebra I test. How does this performance compare with that of other 9th-grade students in the nation? According to the national norms table for Algebra I (Table 31), the percentile band corresponding to a converted score of 160 for 9th-grade students is 75-93. This means that only about 7 per cent of the students in the norms group clearly rank higher than Barbara, while 75 per cent of the students clearly rank lower. Barbara is in the top quarter of the group on this test. This information can be helpful to Barbara and her parents, and to her teacher and guidance counselor in considering the possibilities of future work in mathematics or mathematics-related fields.

How do you compare one student's standing with another student's standing?

Another 9th-grade student, Ted Archer, earned a converted score of 150 on the Algebra I test. The percentile band for this score is 36-66. Can you say that Barbara's standing is higher than Ted's?

The rules for comparing the standings of two students are as follows:

1. *The percentiles to be compared must be drawn from the same norms.*
2. If the percentile bands overlap, it is impossible to say with any certainty that one standing is higher than the other.
3. If the percentile bands do *not* overlap, you can say with considerable certainty that one standing is higher than the other.

Barbara's percentile standing is 75-93 and Ted's is 36-66. The two percentile bands do not overlap. Therefore, the conclusion that Barbara's standing in the national norms group is higher than Ted's standing is justified.

Note that if Ted's score had been 4 converted score points higher, the same conclusion would *not* be warranted. The percentile band for a score of 154 is 48-79, which overlaps Barbara's percentile band. In this case, it could not be said that the standings of the two students were significantly different.

How can SCAT Quantitative results be used to check on Cooperative Mathematics interpretations?

The Cooperative School and College Ability Tests measure developed verbal and quantitative ability, and serve to indicate students' capacity for academic work at successive educational levels. Because performance on the quantitative portion of SCAT is related to performance on the Cooperative Mathematics Tests, SCAT-Q results can be useful in interpreting Cooperative Mathematics results.

SCAT-Q scores were obtained for all students in the publisher's norms groups for the purpose of describing the general quantitative ability levels of these groups. The SCAT results are presented at the foot of each norms table in this *Handbook*. If you have SCAT-Q scores for the students in your group, you can use them for two kinds of checks:

1. To check the over-all performance of your group on the mathematics test in relation to the norms group. Suppose, for example, that a large number of the students in your group fall in the high percentile range of the mathematics norms group. Check the average SCAT-Q score for your group against the SCAT-Q mean score for the norms group. If you find that your group is higher on this measure, then you would expect many of your students to achieve high standings on the Mathematics test.

You can also check the distribution of the SCAT-Q standings of your students, using the SCAT *Manual for Interpreting Scores,* with their standings on the mathematics test. Of course, you would not expect these distributions to match exactly, but in general the distributions should be similar, i.e., the proportions of students with high, middle, or low standings should be about the same on the two tests.

2. To check the mathematics standing of an individual student with his SCAT-Q standing. It is not possible from a single ability score to judge exactly the standing that a student should achieve on the mathematics test. But wide discrepancies between a student's standings on SCAT-Q and the mathematics test may warrant further investigation. Suppose that a student ranks in the lowest quarter of the norms group on the mathematics test, but is in the second quarter or higher on SCAT-Q. In this case, it is likely that the student is capable of higher standing in mathematics. Perhaps the discrepancy can be explained in terms of the student's interest in mathematics, the amount of time he devotes to this subject or other factors not related to ability. Or, perhaps the student was physically or emotionally upset on the day the mathematics test was administered, so that he did not achieve as high a score as he should. Re-testing with an alternate form of the test would be advisable.

How can you compare a student's Cooperative Mathematics standings with his school standings?

Comparison of standings on the Cooperative Mathematics Tests with course grades is helpful in interpreting test results. For this purpose, grades from a single mathematics course or composite grade averages over several mathematics courses can be used. The comparisons are most meaningful in terms of local ranks on the mathematics test. Rank all the students in the local group from highest to lowest on the mathematics score, and divide the distribution into quarters—highest, third, second, and lowest quarters. Similarly, rank the students according to course grades, and divide them into quarters.

In general, you would expect a student to rank in the same quarter on both the Cooperative Mathematics test and course grades. If a student's standings on the two measures differ by as much as a quarter, possible explanations for the discrepancy should be sought. Again, the explanation may lie in the student's interest or the amount of work he devotes to the subject. Perhaps factors other than those measured by the mathematics test are used to determine course grades.

Consideration of the student's general ability level and of his class work, as reflected in course grades and other kinds of teacher evaluation, helps produce more meaningful interpretations of test results. Consideration of all of these factors contributes to sound over-all evaluation of the student's level of proficiency in mathematics.

SCORE RELATIONSHIPS BETWEEN THE PRESENT COOPERATIVE MATHEMATICS TESTS AND EARLIER COOPERATIVE MATHEMATICS TESTS

All of the tests in the Cooperative Mathematics series are entirely new tests, not revisions of older test forms. The abilities measured in corresponding tests in the two series are sufficiently similar, however, to permit comparison of scores. Thus, in order to preserve continuity in on-going testing programs, appropriate transformations from scaled scores on the older tests to Cooperative Mathematics converted scores are provided in Table 3. Note that the transformations are from old to new, *not* new to old. The following scaled-to-converted score transformations are possible:

Scaled Score (earlier tests)	*Converted Score (present tests)*
Mathematics for Grades 7, 8, and 9	Arithmetic
Elementary Algebra	Algebra I
Intermediate Algebra	Algebra II
Plane Geometry	Geometry (Total Score)
Plane Trigonometry	Trigonometry

Scores on older tests not listed cannot be transformed to converted scores on present Cooperative Mathematics Tests.

TABLE 3. Scaled Scores on Earlier Cooperative Mathematics Tests Corresponding to Converted Scores on the Present Tests

Scaled Score	Converted Scores on Present Tests				
	Arithmetic	Algebra I	Algebra II	Geometry	Trigonometry
14	130				
15	131				
16	131				
17	131				
18	131				
19	132				
20	132				
21	132				
22	133				
23	133				
24	133				
25	134				
26	134			130	
27	135			131	
28	135			132	
29	136	135		133	
30	136	135		133	
31	137	136		134	
32	137	136		134	
33	138	137		135	
34	138	138		135	
35	139	138		135	
36	140	139		136	134
37	140	139		136	135
38	141	140	130	136	135
39	142	141	131	137	135
40	142	141	132	137	136
41	143	142	132	137	136
42	144	143	133	138	137
43	144	143	134	138	138
44	145	144	134	139	139
45	146	145	135	139	140
46	147	145	136	140	141
47	148	146	136	140	142
48	149	147	137	141	143
49	150	147	138	142	144
50	151	148	139	142	145
51	152	149	140	143	146
52	153	149	141	144	148
53	154	150	142	145	149
54	156	151	142	146	150
55	157	151	143	147	152
56	158	152	144	148	153
57	159	153	146	149	155
58	161	153	147	150	156
59	162	154	148	152	158
60	163	155	150	153	159
61	164	156	151	154	161
62	166	156	153	155	163
63	167	157	156	157	164
64	168	158	158	159	166
65	169	159	161	160	168
66	170	160	163	162	170
67	171	161	165	164	171
68	171	162	167	166	173
69	172	163	169	168	175
70	173	164	171	170	176
71	173	165	173	173	178
72	174	166	174	175	180
73	174	168	176	177	181
74	175	169	177	178	183
75	175	171		180	184
76	176	172		182	186
77	176	174		184	188
78	176	176		186	189
79		177			191

DEVELOPING AND USING LOCALLY CONSTRUCTED NORMS

How can you develop local norms?

The procedures for constructing local norms are similar to those used to construct publishers' norms. The information necessary for incorporating percentile bands in locally constructed norms for the Cooperative Mathematics Tests is given in Table 4 below. Complete directions are contained in the pamphlet, *Constructing and Using Local Norms*, available on request from the Cooperative Test Division, Educational Testing Service.

How can locally constructed norms be useful?

Locally constructed norms for specific groups of students can be used to increase the interpretive usefulness of tests. Publishers' norms generally permit comparison of students' performance with that of students at the same educational level in the nation. Locally constructed norms permit the test interpreter to define his own comparison group. Thus, he may compare the performance of his students with students in the same school or a group of schools where educational experiences have been similar. Or, he may construct norms for all students admitted to the state university so that he can assess the probable standing of his students in relation to this group.

Tables 5 to 8 in this *Handbook* present illustrative norms data for one specially defined comparison group. Each of these tables is based on the scores of students in 2 or 3 selected suburban school systems. The tables for the suburban schools serve mainly to illustrate how interpretations based on different types of norms may differ from those based on national norms and how the interpretation of test scores can be improved by supplementing national norms with norms based on other reference groups.

Consider the following example for a hypothetical student in one of the suburban schools. Jim Martin, a 7th-grade student, earned a converted score of 156 on the Arithmetic test. Referring to the information at the foot of Table 28, it may be seen that three fourths of the students in the 7th-grade national norms group earned Arithmetic scores lower than 152 (the upper quartile score). Thus, Jim's score is in the top quarter of the scores for 7th-grade arithmetic students nationally. Referring now to the information at the foot of Table 5, it is found that Jim's score of 156 falls between the median score (152) and the upper quartile score (159) for the suburban reference group. Thus, when compared with students in his own and similar schools, Jim's score places him in the next to the top quarter of this group.

The difference in Jim's standings in relation to the two groups is reasonable in view of the higher general quantitative ability of the suburban group and their correspondingly higher scores on the Arithmetic test. Note at the foot of Table 28 for the national norms, that the mean SCAT-Q score (the mean Quantitative score on the Cooperative School and College Ability Test) for the group comprising the national 7th-grade Arithmetic norms is 282. The mean SCAT-Q score for the suburban 7th-grade Arithmetic group (Table 5) is 296, indicating that this group is considerably above the national average in Quantitative ability. Similarly, the mean Arithmetic score for the suburban group is 151, as compared to the mean score of 145 for the national norms group.

Both interpretations of Jim's score are useful, because they answer different questions. When placed in perspective, both interpretations become more meaningful.

TABLE 4. Percentile Band Intervals for the Cooperative Mathematics Tests*

Test	Interval**
Arithmetic	2
Algebra I	2
Algebra II	2
Geometry, Part I	2
Geometry, Total	2
Trigonometry	2
Algebra III	2
Calculus	2
Analytic Geometry	3
Structure of the Number System	2

*Based on standard error of measurement.

**Count up and down this number of score groups (double-score intervals) from the score group in question.

USING ITEM INFORMATION

Information obtained by examining students' responses to separate items or clusters of related items can be especially helpful to teachers and curriculum planners. This information is often overlooked or by-passed, however, because of the time and effort required to assemble it. Item classification tables, Tables 9-27, have been developed to facilitate this process, and the remainder of this section offers suggestions for using item information.

How are the item classification tables organized?

There is a separate item classification table for each of the 19 test forms in the series. Each table lists the item numbers and the correct answer for each item. The percentage of a random sample of the students in the national norms group (or groups) that answered the item correctly is also listed.

Finally, the major topical heading under which the item has been classified is indicated. Some items might appropriately have been classified under more than one heading because the item involves more than one concept or principle. In such cases, however, the item was classified in a single category according to the central intent or main point of the item.

How can item information be used by program evaluators and curriculum planners?

The Cooperative Mathematics Tests represent the combined judgment of many teachers, scholars, and mathematics specialists concerning the important elements of mathematics that are included in the nation's school mathematics programs, whether the approach be "modern" or more traditional in nature. As such, the tests do not in any sense prescribe a particular curriculum; they sample widely-shared elements of existing curricula.

Some of the elements that are included in the tests may not be appropriate for your program, and others that you consider important may not be represented. But, if a test is appropriate for your group, the majority of the items in the test tap concepts and skills included in the instructional goals of your mathematics program. Students' responses to these items, then, are one indication of how well some of your objectives are being achieved.

The starting point is to select the items that are appropriate for your students; i.e., that are included in their course of study. You may also wish to identify items that are not treated directly in the course, but which the students might be expected to answer correctly by reasoning. Then, identify and label the items or groups of items that contribute to specific goals in your program.

Next, tally your students' responses to each of the items selected. This task can easily be done by a clerical assistant or a teacher's aide. For the present purpose, only correct responses need be tallied. It would also be helpful to teachers, however, to see the *kinds* of errors their students make most frequently. Both purposes can be served by tallying the number of students that selected each response to each item.

Finally, convert the counts to percentages by dividing the number of students selecting the response by the total number of students.

If the number of students tested is small, you should tally responses for all of them. If the number is large, however, you may wish to select a random sample of the answer sheets to tally. A sample of 200 answer sheets should be adequate.

Now you are ready to view the test results in relation to your objectives. In the process, many factors should be considered, including the number of students involved in the analysis, the number of items relating to a particular objective, the nature of the content or skill measured by the items, the importance of the particular objective in relation to your over-all goals, and the level of competence you might expect of the students. To illustrate, suppose that you identify an area in which the performance of your group is relatively low; i.e., the percentages of students who answered the items correctly are low. If your results are based on the responses of a small group of students on only one or two items, you could not reach any conclusions concerning the students' competence in that area. The finding might serve only as a cue to look for other evidence on this point. If your group is large, however, and five or more items are involved, the finding may well be worth considering. If the area under consideration concerns a relatively important goal in your program, it is likely that considerable time and effort were devoted to it. If so, you would probably want to investigate further to try to find reasons for the low performance. Are the items you assigned to this category appropriate measures of the abilities you are trying to develop? Did the students encounter similar problems in their class work? Perhaps the trouble lies in their inability to extend or apply what they have learned in class to new problem situations in an unfamiliar context.

What level of performance should you expect of the students? Considering their general ability level and the emphasis given the topic in your program, would you expect 50 per cent, or 75 per cent, or 90 per cent of the students to answer these items correctly? While this is a matter of local decision, it may be helpful to compare your results with those for students nationally. The item classification tables may be used for this purpose.

Analysis of test results in this manner is useful primarily because it deals with specifics and because the evidence it furnishes is objective. Rather than providing answers to curriculum problems, it raises questions and perhaps leads investigation in fruitful directions. It supplements, but does not replace, other types of evidence that must be considered in program evaluation and curriculum planning.

How can item information be used by teachers?

The outcomes of the analysis described above, made on a cross-section of all the students in a school or school district, might have broad instructional implications; that is, program evaluation may suggest departmental or district-wide modifications of instructional approach or procedures as well as revision of course structure.

Individual teachers may also find it helpful to examine the types of errors made by students in their own classes. Which items were missed most frequently by the group? Which concepts and skills are involved? Are the errors related; i.e., do they involve items that are similar in content according to the classification tables or do they require similar skills? Did most of the students who missed an item select the same incorrect choice? Knowledge of the nature of and persistence of students' errors, together with knowledge of the concepts and skills they have developed, may indicate the kinds of review that are needed and suggest modifications in the teaching program to avoid the difficulties in the future.

While a short achievement test cannot be considered precisely diagnostic, a study of errors for individual students may also suggest appropriate procedures. If John's errors seem to be widely spread over the topics included in the test, perhaps he simply needs to devote more time to the course. He may, of course, be doing as well as might be expected in terms of his ability. But if John's errors are concentrated about certain topics, perhaps these are areas that can be strengthened before he enrolls in further mathematics courses.

TABLE 5. Arithmetic: Illustrative Suburban Reference Data

Raw Score			Converted Score	Grade 7		Grade 8		Grade 9	
Form A	Form B	Form C		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
50			176-177						
49		49 - 50	174-175			96 -99.9	99.6		
47 - 48	50	47 - 48	172-173	94 -99.9	99.6	90 -99.9	99.6		
45 - 46	48 - 49	45 - 46	170-171	92 -99.9	98	86 -99.6	96		
43 - 44	46 - 47	43 - 44	168-169	92 -99.6	94	81 -99.6	90		
41 - 42	44 - 45	41 - 42	166-167	88 -98	92	70 -96	86	94 -99.9	99
40	42 - 43	39 - 40	164-165	81 -94	92	65 -90	81	86 -99.9	99
38 - 39	40 - 41	37 - 38	162-163	72 -92	88	48 -86	70	74 -99	94
36 - 37	38 - 39	36	160-161	65 -92	81	40 -81	65	64 -99	86
34 - 35	36 - 37	34 - 35	158-159	62 -88	72	36 -70	48	58 -94	74
33	34 - 35	32 - 33	156-157	53 -81	65	27 -65	40	45 -86	64
31 - 32	32 - 33	30 - 31	154-155	42 -72	62	21 -48	36	40 -74	58
29 - 30	30 - 31	28 - 29	152-153	36 -65	53	15 -40	27	35 -64	45
27 - 28	28 - 29	26 - 27	150-151	28 -62	42	11 -36	21	33 -58	40
25 - 26	26 - 27	24 - 25	148-149	25 -53	36	10 -27	15	27 -45	35
24	24 - 25	22 - 23	146-147	19 -42	28	6 -21	11	20 -40	33
22 - 23	22 - 23	20 - 21	144-145	13 -36	25	5 -15	10	16 -35	27
20 - 21	20 - 21	19	142-143	11 -28	19	4 -11	6	13 -33	20
18 - 19	18 - 19	17 - 18	140-141	10 -25	13	4 -10	5	9 -27	16
16 - 17	16 - 17	15 - 16	138-139	7 -19	11	3 - 6	4	6 -20	13
15	14 - 15	13 - 14	136-137	4 -13	10	2 - 5	4	3 -16	9
13 - 14	12 - 13	11 - 12	134-135	3 -11	7	2 - 4	3	2 -13	6
11 - 12	10 - 11	9 - 10	132-133	2 -10	4	2 - 4	2	2 - 9	3
9 - 10	8 - 9	7 - 8	130-131	2 - 7	3	2 - 3	2	2 - 6	2
8	7	5 - 6	128-129	2 - 4	2	2 - 2	2	2 - 3	2
6 - 7	5 - 6	3 - 4	126-127	2 - 3	2	2 - 2	2	1 - 2	2
4 - 5	3 - 4	1 - 2	124-125	2 - 2	2	2 - 2	2	1 - 2	2
2 - 3	1 - 2	0	122-123	0.1- 2	2	0.1- 2	2	0.1- 2	1
0 - 1	0		120-121	0.1- 2	2	0.1- 2	2	0.1- 2	1
Number of Students				247		263		99	
Number of Schools				2		2		2	
Mean				151		157		151	
Standard Deviation				11		10		10	
Upper Quartile				159		164		159	
Median				152		159		154	
Lower Quartile				145		152		144	
SCAT-Q Mean				296		302		288	
SCAT-Q Standard Deviation				19		19		18	

TABLE 6. Algebra I: Illustrative Suburban Reference Data

Raw Score		Converted Score	Grade 8		Grade 9	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
40	40	176-177				
39	38 - 39	174-175	89 -99.9	97	96 -99.9	99.1
37 - 38	37	172-173	81 -99.9	94	91 -99.9	97
36	35 - 36	170-171	74 -97	89	89 -99.1	96
35	34	168-169	49 -94	81	81 -97	91
33 - 34	32 - 33	166-167	43 -89	74	76 -96	89
32	31	164-165	38 -81	49	72 -91	81
30 - 31	29 - 30	162-163	29 -74	43	59 -89	76
29	28	160-161	26 -49	38	54 -81	72
27 - 28	26 - 27	158-159	14 -43	29	42 -76	59
26	25	156-157	11 -38	26	36 -72	54
25	24	154-155	8 -29	14	25 -59	42
23 - 24	22 - 23	152-153	5 -26	11	20 -54	36
22	21	150-151	5 -14	8	17 -42	25
20 - 21	19 - 20	148-149	4 -11	5	10 -36	20
19	18	146-147	3 - 8	5	8 -25	17
17 - 18	16 - 17	144-145	1.0- 5	4	6 -20	10
16	15	142-143	1.0- 5	3	4 -17	8
15	13 - 14	140-141	1.0- 4	1.0	2 -10	6
13 - 14	12	138-139	1.0- 3	1.0	2 - 8	4
12	10 - 11	136-137	0.1- 1.0	1.0	2 - 6	2
10 - 11	9	134-135	0.1- 1.0	1.0	2 - 4	2
9	8	132-133			0.9- 2	2
7 - 8	6 - 7	130-131			0.7- 2	2
6	5	128-129			0.7- 2	0.9
5	3 - 4	126-127			0.4- 2	0.7
3 - 4	2	124-125			0.2- 0.9	0.7
2	0 - 1	122-123			0.1- 0.7	0.4
0 - 1		120-121			0.1- 0.7	0.2

	Grade 8	Grade 9
Number of Students	102	454
Number of Schools	2	3
Mean	162	156
Standard Deviation	8	9
Upper Quartile	167	162
Median	164	156
Lower Quartile	156	150
SCAT-Q Mean	317	307
SCAT-Q Standard Deviation	10	14

TABLE 7. Geometry: Illustrative Suburban Reference Data—High School

Total (Parts I & II)

Raw Score Form A	Raw Score Form B	Converted Score	Percentile Band	Mid-Percentile Rank
79 - 80		188-189		
77 - 78		186-187		
75 - 76	80	184-185		
73 - 74	77,78 - 79	182-183		
70 - 71,72	75 - 76	180-181		
68 - 69	73 - 74	178-179	97 -99.9	99.3
66 - 67	70 - 71,72	176-177	96 -99.9	98
64 - 65	68 - 69	174-175	94 -99.3	97
62 - 63	66 - 67	172-173	92 -98	96
60 - 61	63 - 64,65	170-171	88 -97	94
58 - 59	61 - 62	168-169	84 -96	92
56 - 57	58,59 - 60	166-167	81 -94	88
54 - 55	56 - 57	164-165	74 -92	84
52 - 53	54 - 55	162-163	68 -88	81
50 - 51	51 - 52,53	160-161	61 -84	74
48 - 49	49 - 50	158-159	50 -81	68
46 - 47	47 - 48	156-157	39 -74	61
44 - 45	44 - 45,46	154-155	27 -68	50
42 - 43	42 - 43	152-153	21 -61	39
40 - 41	39,40 - 41	150-151	16 -50	27
38 - 39	37 - 38	148-149	11 -39	21
36 - 37	35 - 36	146-147	8 -27	16
34 - 35	32 - 33,34	144-145	5 -21	11
32 - 33	30 - 31	142-143	3 -16	8
30 - 31	27,28 - 29	140-141	3 -11	5
28 - 29	25 - 26	138-139	3 - 8	3
26 - 27	23 - 24	136-137	2 - 5	3
24 - 25	20,21 - 22	134-135	1 - 3	3
22 - 23	18 - 19	132-133	1 - 3	2
20 - 21	16 - 17	130-131	0.7- 3	1
18 - 19	13 - 14,15	128-129	0.4- 2	1
16 - 17	11 - 12	126-127	0.4- 1	0.7
14 - 15	8,9 - 10	124-125	0.4- 1	0.4
12 - 13	6 - 7	122-123	0.4- 0.7	0.4
10 - 11	4 - 5	120-121	0.4- 0.4	0.4
8 - 9	1,2 - 3	118-119	0.4- 0.4	0.4
6 - 7	0	116-117	0.4- 0.4	0.4
4 - 5		114-115	0.1- 0.4	0.4
2 - 3		112-113	0.1- 0.4	0.4
0,1		110-111		

Number of Students	273
Number of Schools	2
Mean	155
Standard Deviation	9
Upper Quartile	161
Median	154
Lower Quartile	149
SCAT-Q Mean	308
SCAT-Q Standard Deviation	13

Part I Only

Raw Score Form A	Raw Score Form B	Converted Score	Percentile Band	Mid-Percentile Rank
39 - 40	40	174-175		
38	39	172-173	93 -99.9	99
37	37 - 38	170-171	90 -99.9	97
36	36	168-169	89 -99	95
35	34 - 35	166-167	76 -97	90
34	33	164-165	68 -95	89
32 - 33	32	162-163	63 -93	84
31	30 - 31	160-161	53 -90	76
30	29	158-159	39 -89	68
29	27 - 28	156-157	24 -76	53
28	26	154-155	19 -68	39
26 - 27	25	152-153	17 -63	32
25	23 - 24	150-151	12 -53	24
24	22	148-149	9 -39	19
23	20 - 21	146-147	4 -24	12
22	19	144-145	3 -19	9
20 - 21	18	142-143	3 -17	6
19	16 - 17	140-141	1 -12	4
18	15	138-139	1 - 9	3
17	13 - 14	136-137	1 - 4	1
16	12	134-135	1 - 3	1
14 - 15	10 - 11	132-133	1 - 3	1
13	9	130-131	1 - 1	1
12	8	128-129	1 - 1	1
11	6 - 7	126-127	1 - 1	1
10	5	124-125	1 - 1	1
9	3 - 4	122-123	0.4- 1	1
7 - 8	2	120-121	0.4- 1	1
6	1	118-119	0.4- 1	1
5	0	116-117	0.4- 1	0.4
4		114-115	0.4- 1	0.4
3		112-113	0.1- 0.4	0.4
1 - 2		110-111	0.1- 0.4	0.4
0		108-109	0.1- 0.4	0.4

Number of Students	273
Number of Schools	2
Mean	155
Standard Deviation	9
Upper Quartile	161
Median	155
Lower Quartile	151
SCAT-Q Mean	308
SCAT-Q Standard Deviation	13

TABLE 8. Trigonometry and Algebra II: Illustrative Suburban Reference Data—High School

Trigonometry

Raw Score		Converted Score	Percentile Band	Mid-Percentile Rank
Form A	Form B			
39 - 40		190-191		
38		188-189		
37	40	186-187		
36	39	184-185		
34 - 35	37 - 38	182-183		
33	36	180-181	96 -99.9	99.5
32	35	178-179	93 -99.9	98
31	33 - 34	176-177	87 -99.5	96
30	32	174-175	85 -98	93
28 - 29	31	172-173	84 -97	90
27	29 - 30	170-171	80 -96	87
26	28	168-169	75 -93	85
25	27	166-167	60 -87	80
24	25 - 26	164-165	56 -85	75
22 - 23	24	162-163	48 -84	70
21	22 - 23	160-161	43 -80	60
20	21	158-159	31 -75	48
19	20	156-157	25 -60	43
17 - 18	18 - 19	154-155	21 -56	37
16	17	152-153	17 -48	31
15	16	150-151	11 -43	25
14	14 - 15	148-149	5 -31	17
13	13	146-147	3 -25	11
11 - 12	12	144-145	2 -21	8
10	10 - 11	142-143	2 -17	5
9	9	140-141	1.0-11	3
8	8	138-139	0.5- 5	2
7	6 - 7	136-137	0.5- 3	1.0
5 - 6	5	134-135	0.5- 2	0.5
4	3 - 4	132-133	0.5- 2	0.5
3	2	130-131	0.1- 1.0	0.5
2	1	128-129	0.1- 0.5	0.5
0 - 1	0	126-127	0.1- 0.5	0.5

Number of Students	210
Number of Schools	3
Mean	158
Standard Deviation	10
Upper Quartile	164
Median	158
Lower Quartile	151
SCAT-Q Mean	326
SCAT-Q Standard Deviation	9

Algebra II

Raw Score		Converted Score	Percentile Band	Mid-Percentile Rank
Form A	Form B			
40	40	176-177	97 -99.9	99.3
38 - 39	38 - 39	174-175	94 -99.9	98
37	37	172-173	91 -99.3	97
35 - 36	35 - 36	170-171	82 -98	94
34	34	168-169	76 -97	91
32 - 33	32 - 33	166-167	65 -94	82
31	31	164-165	61 -91	76
30	29 - 30	162-163	51 -82	65
28 - 29	28	160-161	45 -76	61
27	26 - 27	158-159	35 -65	51
25 - 26	25	156-157	27 -61	45
24	23 - 24	154-155	18 -51	35
22 - 23	22	152-153	14 -45	27
21	20 - 21	150-151	11 -35	18
19 - 20	19	148-149	8 -27	14
18	17 - 18	146-147	6 -18	11
16 - 17	16	144-145	5 -14	8
15	14 - 15	142-143	4 -11	6
13 - 14	13	140-141	2 - 8	5
12	11 - 12	138-139	1 - 6	4
11	10	136-137	0.7- 5	2
9 - 10	8 - 9	134-135	0.5- 4	1
8	7	132-133	0.5- 2	0.7
6 - 7	5 - 6	130-131	0.5- 1	0.5
5	4	128-129	0.4- 0.7	0.5
3 - 4	2 - 3	126-127	0.2- 0.5	0.5
2	1	124-125	0.1- 0.5	0.4
0 - 1	0	122-123	0.1- 0.5	0.2

Number of Students	558
Number of Schools	3
Mean	158
Standard Deviation	9
Upper Quartile	165
Median	158
Lower Quartile	152
SCAT-Q Mean	317
SCAT-Q Standard Deviation	11

TABLE 9. Arithmetic, Form A: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Right Answer	B	G	E	H	E	F	C	H	E	H	A	F	D	H	C	H	D	H	D	K	B	G	D	F	D
Grade 7—% Right	87	80	79	89	79	88	76	45	33	65	76	50	78	81	74	56	53	47	78	72	47	58	58	37	66
Grade 8—% Right	87	88	78	89	77	89	79	50	32	64	72	62	70	83	77	64	63	58	81	76	56	62	62	38	67
Grade 9—% Right	81	75	74	80	70	81	68	47	34	63	63	42	63	73	68	52	47	44	73	67	47	52	52	24	65
Basic Laws and Properties of Operation	1			4																20					
Odd and Even Numbers																					21				
Factors and Multiples						6				10					15										
Place Value												12										22		24	
Number Line								8	9																
Ordering and Inclusion																									25
Operations with Whole Numbers			3																						
Fractions and Mixed Numbers											11		13			16			19						
Decimals							7																		
Percentage																									
Conversions (Decimals, Fractions, Per Cent)																		18							
Denominate Numbers					5																				
Ratio and Proportion														14											
Scales																							23		
Averages		2																							
Graphs																									
Estimation																	17								

Item Number	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Right Answer	K	A	J	A	G	B	G	D	F	C	H	D	K	A	K	A	G	A	J	B	H	E	H	A	G
Grade 7—% Right	61	61	65	20	62	36	35	50	28	40	38	60	28	47	32	26	51	31	10	[illegible]	17	16	33	15	13
Grade 8—% Right	65	69	67	47	71	47	26	60	45	53	50	59	30	55	42	38	59	39	19	32	20	20	35	25	19
Grade 9—% Right	50	57	55	26	55	33	21	38	23	41	37	48	27	42	29	23	31	21	12	20	15	15	31	12	11
Basic Laws and Properties of Operation							32	33	34																
Odd and Even Numbers																				45					50
Factors and Multiples																									
Place Value																									
Number Line																									
Ordering and Inclusion											36										46				
Operations with Whole Numbers				29																			48	49	
Fractions and Mixed Numbers			28																						
Decimals	26															41									
Percentage															40				44						
Conversions (Decimals, Fractions, Per Cent)																	42								
Denominate Numbers		27			30									39											
Ratio and Proportion						31				35															
Scales																									
Averages																						47			
Graphs												37	38					43							
Estimation																									

TABLE 10. Arithmetic, Form B: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Right Answer	D	G	A	J	D	H	A	H	A	J	D	G	E	H	B	K	A	J	D	H	E	G	E	J	E
Grade 7—% Right	80	67	71	76	68	76	73	82	68	64	47	65	46	60	77	60	90	50	57	49	55	51	52	38	57
Grade 8—% Right	88	80	84	88	78	84	82	86	76	74	53	76	46	72	82	69	93	57	62	55	68	63	60	40	65
Grade 9—% Right	84	71	76	79	67	76	71	81	61	61	45	69	47	58	76	57	88	55	49	47	56	49	51	32	56
Basic Laws and Properties of Operation									9										19						
Odd and Even Numbers																							23		
Factors and Multiples					5					10										20					
Place Value																								24	25
Number Line																									
Ordering and Inclusion							7																		
Operations with Whole Numbers						6									15										
Fractions and Mixed Numbers													13	14		16									
Decimals		2		4																					
Percentage																					21				
Conversions (Decimals, Fractions, Per Cent)	1																								
Denominate Numbers																									
Ratio and Proportion																									
Scales												12										22			
Averages								8			11														
Graphs			3														17	18							
Estimation																									

Item Number	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Right Answer	H	B	K	E	G	A	G	D	G	C	F	C	J	B	G	C	J	B	J	A	K	D	F	E	K
Grade 7—% Right	40	23	44	66	58	42	46	32	49	51	41	19	34	17	44	34	33	38	25	27	10	8	9	19	8
Grade 8—% Right	45	49	55	76	73	57	59	43	63	62	48	23	50	30	60	50	49	53	30	37	15	18	13	26	14
Grade 9—% Right	44	28	46	69	58	47	46	30	52	51	38	17	35	17	53	34	41	44	22	25	11	9	9	21	8
Basic Laws and Properties of Operation						31										41								49	
Odd and Even Numbers			28																						
Factors and Multiples																									
Place Value																									
Number Line								33																	
Ordering and Inclusion												37											48		
Operations with Whole Numbers		27		29						35	36						42								
Fractions and Mixed Numbers									34																50
Decimals																				45					
Percentage													38												
Conversions (Decimals, Fractions, Per Cent)														39											
Denominate Numbers																		43	44						
Ratio and Proportion					30		32								40							47			
Scales																									
Averages																					46				
Graphs																									
Estimation	26																								

TABLE 11. Arithmetic, Form C: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Right Answer	D	H	B	F	D	J	C	J	C	H	D	J	B	F	B	H	C	F	C	H	E	K	B	H	A
Grade 7—% Right	62	31	80	86	61	86	77	54	73	63	43	51	44	28	42	53	64	50	47	76	51	43	47	44	29
Grade 8—% Right	74	37	80	93	60	91	86	61	74	66	48	50	49	34	54	60	74	60	59	81	57	51	52	52	45
Grade 9—% Right	64	28	77	89	60	84	81	52	71	54	39	44	40	26	36	49	58	57	45	80	51	45	38	42	28
Basic Laws and Properties of Operation																			19						
Odd and Even Numbers		2								10												22			
Factors and Multiples						6					11						17								
Place Value												12											23		
Number Line																				20					
Ordering and Inclusion																									
Operations with Whole Numbers			3										13											24	
Fractions and Mixed Numbers	1															16		18							25
Decimals									9																
Percentage																									
Conversions (Decimals, Fractions, Per Cent)																									
Denominate Numbers																									
Ratio and Proportion								8						14											
Scales							7														21				
Averages															15										
Graphs				4	5																				

Item Number	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Right Answer	G	B	J	A	F	C	F	E	K	C	F	E	J	A	G	E	H	E	K	D	G	D	H	B	K
Grade 7—% Right	74	20	31	38	46	58	60	35	44	54	37	40	42	33	28	20	42	44	30	33	31	24	3	21	26
Grade 8—% Right	88	39	44	45	60	70	66	39	56	66	50	40	49	38	33	27	50	58	36	44	36	33	8	29	37
Grade 9—% Right	77	28	37	31	57	58	54	31	46	51	38	41	47	31	27	17	42	47	32	31	25	28	3	21	26
Basic Laws and Properties of Operation				29			32	33							40							47			
Odd and Even Numbers																									
Factors and Multiples																									
Place Value																									
Number Line																									
Ordering and Inclusion												37									46		48		
Operations with Whole Numbers		27				31																			50
Fractions and Mixed Numbers																			44						
Decimals																		43							
Percentage	26				30				34								42								
Conversions (Decimals, Fractions, Per Cent)			28																						
Denominate Numbers											36					41				45					
Ratio and Proportion										35															
Scales																									
Averages																								49	
Graphs													38	39											

TABLE 12. Structure of the Number System, Form A: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	C	F	A	J	C	K	D	J	D	F	B	K	B	H	B	G	A	F	C	J	E	G	C	H	D	G	C	F	E	J	A	H	B	G	E	J	C	K	E	K
Grade 7—% Right	84	81	77	77	42	52	65	51	49	42	58	42	48	51	37	30	32	48	42	33	45	45	32	15	38	38	32	40	26	21	21	19	17	19	20	24	29	16	13	9
Grade 8—% Right	87	87	74	79	51	75	70	59	62	42	61	71	57	56	35	38	48	57	44	38	44	45	40	22	40	54	36	51	39	31	26	25	23	48	34	22	31	26	15	19
Arithmetic Judgment					5																21										31		33		35			38		
Commutative, Associative, and Distributive Laws	1	2						8								16		18					23																	
Closure																								24								32								
Inverses and Identities																											27													
Properties of Integers																	17													30				34						
Place Value							7															22																		
Factors, Divisors, and Multiples			3	4					9		11														25	26										36				40
Prime Numbers										10																														
Number Lines						6						12																												
Zero Denominator																												28												
Number Systems (Bases other than 10)														14	15				19	20									29										39	
Modular Arithmetic																																					37			
Roman Numerals													13																											

TABLE 13. Structure of the Number System, Form B: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	C	H	A	H	E	K	C	G	B	F	E	J	D	G	C	K	E	H	D	K	B	F	B	H	E	J	A	G	C	H	E	F	D	F	D	F	D	K	E	J
Grade 7—% Right	89	92	60	73	77	39	61	56	53	55	41	57	52	44	48	57	53	53	64	57	47	51	35	42	31	32	33	27	28	26	19	22	41	19	7	20	7	18	7	20
Grade 8—% Right	91	94	76	80	90	34	67	56	64	65	60	62	52	59	60	70	57	62	53	65	56	46	40	53	38	37	39	52	38	45	21	33	41	34	52	21	29	28	19	33
Arithmetic Judgment					5								13	14																	31								39	
Commutative, Associative, and Distributive Laws		2	3				7									16								24	25													38		
Closure															15																	32								
Inverses and Identities											11																			30										
Properties of Integers																																		34	35					40
Place Value												12						18											29											
Factors, Divisors, and Multiples	1			4					9								17				21					26							33			36				
Prime Numbers																				20																				
Number Lines																											27										37			
Zero Denominator						6																																		
Number Systems (Bases other than 10)										10									19			22	23																	
Modular Arithmetic																												28												
Roman Numerals								8																																

TABLE 14. Algebra I, Form A: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	C	F	C	H	D	J	A	H	B	K	D	G	E	H	D	J	D	F	E	F	E	F	E	G	A	J	C	G	C	G	D	H	E	K	A	G	D	K	A	G
Grade 8—% Right	96	91	72	53	94	84	32	90	76	48	57	70	89	74	80	42	89	81	43	65	64	60	38	62	56	48	52	61	41	64	57	28	35	47	54	60	38	36	28	50
Grade 9—% Right	94	89	61	43	90	78	24	88	77	48	59	65	83	73	79	40	85	84	43	61	62	58	34	60	49	42	45	63	34	58	59	21	34	38	45	49	25	28	22	38
Terminology							7																																	
Combining Terms			3		5					10																														
Translation from Verbal to Algebraic Expressions		2				6													19											30										
Solution of Linear Equations	1												13										23															38		
Substitution in Algebraic Expressions and Equations				4				8												20						26														
Solution of Literal Equations																16																							39	
Exponents and Roots									9					14								22																		
Algebraic Multiplication and Division															15						21				25			28												
Averages																	17																							
Systems of Linear Equations											11																				31									
Graphs of Linear Functions												12																				32								
Linear Inequalities and Order																													29				33		35					40
Factoring and Quadratic Equations																		18						24										34			37			
Division by Zero																											27													
Variation																																				36				

TABLE 15. Algebra I, Form B: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	A	J	A	J	E	K	B	H	B	K	C	J	E	K	A	H	A	H	B	H	E	G	E	G	B	H	D	F	A	H	C	K	B	K	B	J	A	J	D	H
Grade 8—% Right	91	64	96	75	80	83	41	50	68	53	76	48	73	84	75	54	61	89	70	67	39	79	51	49	59	38	53	18	55	52	53	41	13	44	74	24	26	26	49	64
Grade 9—% Right	90	59	95	63	75	81	39	50	67	50	70	54	70	80	79	58	58	90	69	65	45	75	48	42	52	30	49	22	55	50	49	48	13	34	62	28	21	18	43	56
Terminology							7																																	
Combining Terms		2	3									12																												
Translation from Verbal to Algebraic Expressions				4					9				13													26														
Solution of Linear Equations	1																17										27											38		
Substitution in Algebraic Expressions and Equations						6		8								16									25															
Solution of Literal Equations																																					37			
Exponents and Roots											11								19		21																			
Algebraic Multiplication and Division					5									14				18				22	23																	
Averages																																			35					
Systems of Linear Equations																				20										30										
Graphs of Linear Functions										10																							33							
Linear Inequalities and Order																								24				28								36				40
Factoring and Quadratic Equations															15														29			32							39	
Division by Zero																															31									
Variation																																		34						

TABLE 16. Algebra II, Form A: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	B	J	E	H	B	F	C	J	E	F	E	H	D	J	E	K	D	K	C	G	A	J	C	G	A	F	B	F	C	K	C	G	C	H	D	F	C	K	B	F
High School—% Right	88	90	83	64	71	77	79	73	63	63	53	30	54	49	34	57	24	55	59	51	66	57	41	49	52	57	57	47	52	57	52	37	40	15	46	47	21	14	30	38
Operations with Algebraic Expressions		2			5				9						15							22																		
Roots and Powers of Numbers	1					6		8			11																							34						
Solution of Linear Equations and Inequalities			3																														33					38		
Solution of Quadratic Equations and Inequalities				4																																				
Solution of Systems of Equations and Inequalities							7						13							20					25															
Solution of "Word Problems"										10																				30										
Properties of Linear Functions												12					17											28												
Properties of Quadratic Functions																			19				23				27				31					36				40
Factoring																		18																						
Progressions														14										24																
Logarithms																16																							39	
Exponential Equations and Equations Involving Radicals																					21					26														
Complex Numbers																													29			32								
Evaluation of a Function																																			35					
Absolute Value																																					37			

TABLE 17. Algebra II, Form B: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	B	J	E	H	C	J	A	K	D	J	B	K	E	H	E	F	D	G	B	F	C	H	B	F	B	F	C	G	C	J	B	J	A	F	B	H	E	J	B	J
High School—% Right	81	89	74	73	78	68	59	46	61	64	71	73	41	54	51	37	59	79	55	65	53	23	57	34	28	56	50	23	50	43	41	22	44	18	29	41	35	22	17	23
Operations with Algebraic Expressions		2		4					9						15											26														
Roots and Powers of Numbers	1						7			10			13																								37			
Solution of Linear Equations and Inequalities			3																																35					40
Solution of Quadratic Equations and Inequalities						6																			25															
Solution of Systems of Equations and Inequalities								8			11																				31									
Solution of "Word Problems"												12						18																						
Properties of Linear Functions																16			19															34						
Properties of Quadratic Functions																				20	21						27	28	29				33							
Factoring																								24																
Progressions														14									23																	
Logarithms																																32						38		
Exponential Equations and Equations Involving Radicals					5																															36				
Complex Numbers																						22								30										
Evaluation of a Function																	17																							
Absolute Value																																							39	

TABLE 18. Geometry, Form A (Parts I and II): Item Content Classification

Item Number	Part	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	I	D	J	E	J	A	K	C	J	B	F	B	G	C	K	B	G	C	J	E	F	B	F	E	H	A	K	E	F	E	F	C	H	B	F	D	H	B	G	E	H
	II	E	H	A	F	B	H	A	G	E	H	D	H	A	J	D	F	B	J	A	G	A	J	C	K	C	G	E	K	D	K	C	J	B	K	E	J	E	G	B	H
High School—% Right	I	85	66	96	82	87	87	96	95	90	95	94	86	82	64	87	78	57	70	82	54	59	42	73	31	30	86	35	80	78	59	63	35	60	26	15	38	13	26	26	29
	II	58	62	66	65	59	46	46	55	46	27	55	50	47	60	42	34	64	38	31	54	46	14	52	46	31	42	27	37	20	33	21	20	15	15	20	12	5	11	14	9
Angle Relations and Measures	I	1		3	4		6																																		
	II						6																																		
Angle Relations, Parallel Lines	I										10				14																30										
	II																																								
Properties of Triangles	I								8				12	13		15												27								35			38		
	II																16														30				34						
Areas and Perimeters (Plane Figures except Circles)	I		2			5																					26							33			36				
	II																					21																			
Circles	I							7				11					16			19		21																			
	II		2		4											15				19				23					28											39	
Circumference and Area of Circles	I																																					37			
	II	1												13																											
Applications of Pythagorean Theorem	I																	17																							
	II					5																								29						35	36				
Properties of Polygons (More than 3 sides)	I																		18					23	24																40
	II			3					8										18						24																40
Congruence	I									9																				29		31									
	II							7													20							27													
Similarity	I																						22												34					39	
	II																																32	33				37			
Logic and Nature of Proof	I																				20								28				32								
	II														14			17								25															
Coordinate Geometry	I																									25															
	II										10																26														
Solids	I																																								
	II									9			12																										38		
Parallelism and Perpendicularity in Space	I																																								
	II											11											22																		
Locus in Space	I																																								
	II																															31									

TABLE 19. Geometry, Form B (Parts I and II): Item Content Classification

Item Number	Part	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	I	C	K	C	J	C	F	A	J	C	G	E	H	A	G	D	G	D	K	E	H	E	J	B	G	C	F	D	F	B	K	B	F	B	J	C	G	E	J	D	J
	II	D	H	D	G	D	J	E	F	B	H	E	K	E	F	D	H	C	F	A	K	C	J	E	F	D	J	B	F	C	J	B	J	D	H	B	F	E	F	D	G
High School—% Right	I	89	73	71	83	97	76	70	80	58	53	63	83	66	80	67	80	19	78	73	32	80	62	38	39	66	48	73	74	61	36	35	31	48	37	64	47	28	52	18	24
	II	76	68	76	48	56	74	76	57	71	45	48	35	73	75	52	47	30	53	52	44	51	38	55	55	50	22	26	18	31	35	27	34	16	13	22	14	34	15	12	9
Angle Relations and Measures	I	1		3										13																											
	II																																								
Angle Relations, Parallel Lines	I		2						8						14																										
	II	1																																							
Properties of Triangles	I					5	6						12				16		18																	35		37			
	II											11										21									30		32	33							
Areas and Perimeters (Plane Figures except Circles)	I									9										19		21													34						
	II																												28										38		
Circles	I											11						17												29									38		
	II				4					9	10						16							23	24	25															
Circumference and Area of Circles	I																				20																			39	
	II			3					8																																
Applications of Pythagorean Theorem	I																							23				27													
	II																						22							29					34						
Properties of Polygons (More than 3 sides)	I				4											15											26														40
	II		2													15												27								35		37			
Congruence	I							7																								31									
	II														14												26														
Similarity	I																						22		24	25															
	II					5		7																																39	
Logic and Nature of Proof	I										10																		28					33			36				
	II													13						19																					
Coordinate Geometry	I																														30										
	II						6						12																												
Solids	I																																								
	II																	17	18													31									
Parallelism and Perpendicularity in Space	I																																32								
	II																																				36				
Locus In Space	I																																								
	II																				20																				40

TABLE 20. Trigonometry, Form A: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	D	K	E	F	A	H	A	J	E	F	A	G	D	K	B	G	C	J	B	H	A	J	C	H	B	H	D	H	B	K	B	G	C	J	C	F	E	F	D	H
High School—% Right	73	77	46	49	59	77	62	57	65	52	48	50	52	50	50	52	47	56	30	42	28	40	34	36	24	30	41	34	34	13	19	14	21	24	14	15	16	13	21	13
College—% Right	57	78	44	53	59	77	66	52	67	52	53	53	52	48	45	49	40	53	26	36	32	43	29	46	20	21	41	28	31	11	24	13	15	16	11	7	7	8	10	8
Definition of Trigonometric Functions		2					7																																	
Radian Measure of Angles																		18		20																				
Interpolation in Tables								8																																
Trigonometric Functions of Special Angles	1		3	4																	21																			
Functions of (Positive and Negative) Angles in Different Quadrants																									25		27					32						38		
Inverse Trigonometric Functions																												28												
Fundamental Identities									9		11	12				16																								
Addition and Double Angle Formulas																			19																	36	37			
Solution of Right Triangles					5					10			13																											
Area of Triangles															15											26														
Trigonometric Equations						6								14									23											34						
Trigonometric Inequalities																						22							29											40
Laws of Sines and Cosines																	17																33						39	
Periodicity and Amplitude																								24							31									
Graphs of Trigonometric Functions																														30					35					

TABLE 21. Trigonometry, Form B: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	D	H	C	F	E	F	C	F	D	G	E	G	D	G	B	H	B	J	B	G	A	J	B	H	C	K	D	G	E	J	E	G	E	F	A	F	D	F	D	K
High School—% Right	56	63	51	63	57	42	34	59	71	67	60	55	60	59	52	49	62	47	49	32	43	38	31	41	37	31	39	35	31	35	14	24	17	27	23	16	20	13	9	12
College—% Right	56	55	51	60	56	49	32	62	58	63	56	53	57	58	55	40	63	34	49	32	41	37	42	29	35	32	31	32	24	25	11	20	15	14	17	10	13	9	6	9
Definition of Trigonometric Functions				4									13											24																
Radian Measure of Angles												12													25															
Interpolation in Tables										10																														
Trigonometric Functions of Special Angles		2	3		5	6																																		
Functions of (Positive and Negative) Angles in Different Quadrants																												28						34	35					
Inverse Trigonometric Functions																		18														32								
Fundamental Identities	1						7									16			19																					
Addition and Double Angle Formulas																						22									31									
Solution of Right Triangles									9																													38		
Area of Triangles														14							21																			
Trigonometric Equations															15														29								37			
Trigonometric Inequalities								8																			27													40
Laws of Sines and Cosines																	17													30						36			39	
Periodicity and Amplitude											11												23																	
Graphs of Trigonometric Functions																				20						26							33							

TABLE 22. Algebra III, Form A: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	B	K	E	H	B	H	A	H	D	K	D	K	C	J	B	G	A	H	B	G	A	F	E	F	E	F	D	G	A	K	E	H	E	H	C	J	A	G	D	J
College—% Right	77	64	76	84	74	62	64	49	52	73	36	51	63	30	78	37	40	34	35	25	59	27	36	57	30	46	35	29	20	57	20	16	24	33	18	20	14	15	10	19
Algebraic Fractions		2					7																																	
Equations of First Degree				4		6			9																															
Equations of Second Degree			3												15																								39	
Equations of Degree > 2										10								18																						
Systems of Equations	1																				21			24														38		
Functions					5									14																						36				
Exponents and Exponential Equations								8																			27													
Binomial Expansion												12																												
Complex Numbers													13																				33							
Logarithms																16							23									32								
Determinants																	17									26														
Graphs and Coordinates																			19										29					34			37			
Properties of Polynomials											11									20		22																		
Inequalities																									25			28			31									
Series and Sequences																														30					35					
Absolute Value																																								40

TABLE 23. Algebra III, Form B: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Right Answer	A	F	E	J	C	K	A	K	A	H	A	K	C	G	B	J	E	G	C	J	A	K	C	F	E	G	B	J	B	H	C	F	B	J	D	G	D	H	D	K
High School—% Right	90	87	86	97	93	72	82	88	97	89	76	86	84	92	66	49	60	67	55	46	62	62	54	49	37	55	31	62	44	37	51	36	30	41	34	34	23	20	20	24
College—% Right	71	78	65	90	82	61	67	72	95	67	60	72	75	78	57	39	50	54	37	34	36	50	37	39	28	42	17	39	31	22	29	31	22	24	23	17	17	13	9	12
Algebraic Fractions			3				7						13																											
Equations of First Degree	1				5																																			
Equations of Second Degree								8	9		11																		29										39	
Equations of Degree > 2																		18																				38		
Systems of Equations		2																															33							
Functions				4													17															32								
Exponents and Exponential Equations						6				10																								34						
Binomial Expansion																			19																					
Complex Numbers												12														26														
Logarithms																							23					28								36				
Determinants																								24																40
Graphs and Coordinates															15					20											31						37			
Properties of Polynomials																16														30										
Inequalities																						22			25		27													
Series and Sequences														14							21																			
Absolute Value																																			35					

TABLE 24. Analytic Geometry, Form A: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Right Answer	B	H	C	K	D	H	B	G	E	F	E	J	B	K	A	G	D	H	C	F	D	G	C	F	A	K	A	K	B	J	A	F	B	J	C
College—% Right	82	87	82	84	78	80	76	75	63	70	66	72	65	53	48	53	46	59	28	42	50	41	39	35	34	33	36	28	14	20	13	17	14	12	14
Distance	1																						23												
Coordinates on Graphs		2																									27								
Lines—Equations, Intercepts										10	11	12																							
Slope, Parallelism, Perpendicularity				4		6	7	8							15			18																	
Symmetry									9																										
Properties of Conics			3											14						20													33		
Curve Recognition					5																							28			31				
Translation and Rotation													13			16																			
Polar Coordinates																	17							24		26						32			
Locus																			19										29						
Domain of a Function																					21														
Inequalities																									25										
Parametric Equations																														30				34	
3-Dimensional Geometry																						22													35

TABLE 25. Analytic Geometry, Form B: Item Content Classification

Item Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Right Answer	E	H	D	H	A	H	D	J	E	F	B	G	D	K	D	G	B	J	E	G	C	J	E	F	E	F	A	G	C	H	A	K	D	H	C
High School—% Right	78	86	85	84	66	79	87	75	69	67	76	80	76	68	72	45	73	53	59	56	54	25	61	41	38	39	39	25	33	23	42	26	27	23	22
College—% Right	73	87	81	81	59	77	78	64	69	76	76	77	72	54	69	41	69	47	52	45	48	20	52	34	26	30	28	17	26	19	36	12	14	19	17
Distance								8			11																								
Coordinates on Graphs	1				5																														
Lines—Equations, Intercepts		2							9				13																						
Slope, Parallelism, Perpendicularity			3	4			7								15	16		18																	
Symmetry																											27								
Properties of Conics										10														24		26		28						34	
Curve Recognition						6								14						20										30					
Translation and Rotation												12									21														
Polar Coordinates																													29			32			35
Locus																						22	23												
Domain of a Function																			19																
Inequalities																									25								33		
Parametric Equations																	17																		
3-Dimensional Geometry																															31				

TABLE 26. Calculus, Form A (Parts I and II)*: Item Content Classification

	Part	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Item Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Right Answer	I	C	K	A	G	C	F	E	J	D	G	C	J	A	G	D	F	B	J	E	H	A	H	A	F	C	K	B	K	B	H
	II	C	G	C	K	D	F	E	F	C	J	B	H	D	H	A	K	A	H	A	J	D	H	B	F	A	K	D	J	E	G
College—% Right	I	90	80	78	92	80	61	79	77	85	52	81	54	51	45	24	43	51	39	46	32	20	52	28	35	26	34	24	18	16	21
	II	70	67	69	70	80	62	50	63	60	71	62	48	50	34	42	38	35	45	47	20	41	30	34	23	19	28	19	16	10	18
Points and Lines	I	1					6																								
	II																														
Rectangular and Polar Coordinates	I																16														
	II																														
Relation of e^x and ln x	I																														
	II							7																							
Limits, Continuity, Definition of Derivative	I												12								20									29	
	II												12									21									
Differentiation	I		2	3					8														22		24		26				
	II														14																
Slope, Tangent, Normal at a Point	I					5					10					15															
	II			3																					24						
Other Properties of Functions and Graphs**	I													13				17						23				27	28		30
	II																									25					
Chain Rule and Related Rates	I														14											25					
	II																	17													
Velocity and Acceleration	I																		18												
	II					5																									
Mean Value Theorem	I																														
	II																						22								
Approximation (Differential)	I																			19											
	II																														
Properties of the Integral	I																														
	II										10						16												28		
Formal Integration—Basic Formulas	I				4							11																			
	II	1	2		4				8	9		11																			
Integration by Substitution	I																														
	II						6														20										
Area, Volume, Arc Length	I									9																					
	II													13					18	19				23							30
Average Value of a Function	I																														
	II																											27			
Simple Differential Equations	I							7														21									
	II															15											26			29	

*In Part I of Forms A and B, all functions used are algebraic. Transcendental functions are included in Part II.

**This includes points of inflection, concavity, maxima, minima, asymptotes, zeros, etc.

TABLE 27. Calculus, Form B (Parts I and II)*: Item Content Classification

	Part	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Item Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Right Answer	I	C	J	B	K	C	J	A	F	B	K	E	F	D	H	A	H	A	G	E	J	D	K	D	F	C	J	E	G	D	G
	II	D	G	A	G	E	K	C	G	A	J	C	F	C	F	A	H	B	H	D	G	E	K	C	H	B	G	D	G	E	J
High School—% Right	I	87	90	90	92	59	91	81	89	96	63	83	58	70	80	51	55	70	39	57	43	37	50	23	45	47	44	41	27	43	38
	II	83	87	73	75	70	71	34	55	65	55	38	44	50	50	47	48	57	52	42	36	61	51	47	9	41	27	20	36	21	18
College—% Right	I	86	73	92	80	65	82	68	84	91	53	79	42	62	75	31	60	48	30	39	40	24	28	27	30	22	33	21	19	31	17
	II	70	80	66	82	62	50	31	48	55	45	45	40	47	43	38	38	48	32	28	28	44	39	34	12	30	29	16	21	13	14
Points and Lines	I	1						7																							
	II																														
Rectangular and Polar Coordinates	I																				20										
	II																														
Relation of e^x and ln x	I																														
	II										10																				
Limits, Continuity, Definition of Derivative	I																16					21								29	
	II											11					16														
Differentiation	I				4	5	6				10																	27			
	II							7																							
Slope, Tangent, Normal at a Point	I		2													15			18						24						
	II												12											23							
Other Properties of Functions and Graphs**	I												12	13				17		19			22				26		28		
	II																			19											
Chain Rule and Related Rates	I														14																30
	II			3																					24						
Velocity and Acceleration	I								8																						
	II																				20										
Mean Value Theorem	I																														
	II																										26				
Approximation (Differential)	I																							23							
	II																														
Properties of the Integral	I																														
	II								8														22						28		
Formal Integration—Basic Formulas	I			3						9																					
	II	1				5				9					14	15															
Integration by Substitution	I																														
	II				4									13																	
Area, Volume, Arc Length	I											11																			
	II		2																18			21				25					30
Average Value of a Function	I																														
	II																											27			
Simple Differential Equations	I																									25					
	II						6											17												29	

*In Part I of Forms A and B, all functions used are algebraic. Transcendental functions are included in Part II.

**This includes points of inflection, concavity, maxima, minima, asymptotes, zeros, etc.

TABLE 28. Arithmetic: National Norms

Raw Score			Converted Score	Grade 7		Grade 8		Grade 9	
Form A	Form B	Form C		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
50			176-177						
49		49 - 50	174-175						
47 - 48	50	47 - 48	172-173	99.5-99.9	99.9	97 -99.9	99.9		
45 - 46	48 - 49	45 - 46	170-171	98 -99.9	99.9	95 -99.9	99	99.5-99.9	99.9
43 - 44	46 - 47	43 - 44	168-169	98 -99.9	99.5	93 -99.9	97	99.2-99.9	99.7
41 - 42	44 - 45	41 - 42	166-167	96 -99.9	98	89 -99	95	98 -99.9	99.5
40	42 - 43	39 - 40	164-165	93 -99.5	98	83 -97	93	96 -99.7	99.2
38 - 39	40 - 41	37 - 38	162-163	90 -98	96	77 -95	89	92 -99.5	98
36 - 37	38 - 39	36	160-161	85 -98	93	71 -93	83	88 -99.2	96
34 - 35	36 - 37	34 - 35	158-159	83 -96	90	68 -89	77	85 -98	92
33	34 - 35	32 - 33	156-157	77 -93	85	59 -83	71	78 -96	88
31 - 32	32 - 33	30 - 31	154-155	70 -90	83	52 -77	68	69 -92	85
29 - 30	30 - 31	28 - 29	152-153	62 -85	77	44 -71	59	61 -88	78
27 - 28	28 - 29	26 - 27	150-151	54 -83	70	37 -68	52	51 -85	69
25 - 26	26 - 27	24 - 25	148-149	49 -77	62	33 -59	44	46 -78	61
24	24 - 25	22 - 23	146-147	41 -70	54	25 -52	37	36 -69	51
22 - 23	22 - 23	20 - 21	144-145	32 -62	49	17 -44	33	28 -61	46
20 - 21	20 - 21	19	142-143	24 -54	41	12 -37	25	21 -51	36
18 - 19	18 - 19	17 - 18	140-141	21 -49	32	10 -33	17	17 -46	28
16 - 17	16 - 17	15 - 16	138-139	14 -41	24	7 -25	12	12 -36	21
15	14 - 15	13 - 14	136-137	8 -32	21	4 -17	10	7 -28	17
13 - 14	12 - 13	11 - 12	134-135	4 -24	14	2 -12	7	4 -21	12
11 - 12	10 - 11	9 - 10	132-133	2 -21	8	0.7-10	4	2 -17	7
9 - 10	8 - 9	7 - 8	130-131	1 -14	4	0.4- 7	2	2 -12	4
8	7	5 - 6	128-129	0.6- 8	2	0.3- 4	0.7	1 - 7	2
6 - 7	5 - 6	3 - 4	126-127	0.3- 4	1	0.2- 2	0.4	1 - 4	2
4 - 5	3 - 4	1 - 2	124-125	0.3- 2	0.6	0.2- 0.7	0.3	0.9- 2	1
2 - 3	1 - 2	0	122-123	0.1- 1	0.3	0.1- 0.4	0.2	0.1- 2	1
0 - 1	0		120-121	0.1- 0.6	0.3	0.1- 0.3	0.2	0.1- 1	0.9

	Grade 7	Grade 8	Grade 9
Number of Students	3338	3632	2492
Number of Schools	114	120	98
Mean	145	150	146
Standard Deviation	10	10	9
Upper Quartile	152	157	152
Median	145	150	146
Lower Quartile	138	143	139
SCAT-Q Mean	282	291	287
SCAT-Q Standard Deviation	18	19	15

TABLE 29. Arithmetic: Urban Norms

Raw Score			Converted Score	Grade 7		Grade 8		Grade 9	
Form A	Form B	Form C		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
50			176-177						
49		49 - 50	174-175	99.8-99.9	99.9				
47 - 48	50	47 - 48	172-173	99.3-99.9	99.9	97 -99.9	99.9		
45 - 46	48 - 49	45 - 46	170-171	98 -99.9	99.8	94 -99.9	98		
43 - 44	46 - 47	43 - 44	168-169	97 -99.9	99.3	91 -99.9	97	99.2-99.9	99.9
41 - 42	44 - 45	41 - 42	166-167	95 -99.8	98	87 -98	94	99 -99.9	99.6
40	42 - 43	39 - 40	164-165	92 -99.3	97	81 -97	91	97 -99.9	99.2
38 - 39	40 - 41	37 - 38	162-163	89 -98	95	73 -94	87	94 -99.6	99
36 - 37	38 - 39	36	160-161	85 -97	92	67 -91	81	90 -99.2	97
34 - 35	36 - 37	34 - 35	158-159	82 -95	89	63 -87	73	87 -99	94
33	34 - 35	32 - 33	156-157	77 -92	85	55 -81	67	80 -97	90
31 - 32	32 - 33	30 - 31	154-155	73 -89	82	49 -73	63	72 -94	87
29 - 30	30 - 31	28 - 29	152-153	65 -85	77	41 -67	55	65 -90	80
27 - 28	28 - 29	26 - 27	150-151	56 -82	73	36 -63	49	56 -87	72
25 - 26	26 - 27	24 - 25	148-149	52 -77	65	33 -55	41	51 -80	65
24	24 - 25	22 - 23	146-147	45 -73	56	26 -49	36	42 -72	56
22 - 23	22 - 23	20 - 21	144-145	36 -65	52	19 -41	33	34 -65	51
20 - 21	20 - 21	19	142-143	29 -56	45	14 -36	26	26 -56	42
18 - 19	18 - 19	17 - 18	140-141	26 -52	36	12 -33	19	23 -51	34
16 - 17	16 - 17	15 - 16	138-139	18 -45	29	8 -26	14	16 -42	26
15	14 - 15	13 - 14	136-137	11 -36	26	4 -19	12	10 -34	23
13 - 14	12 - 13	11 - 12	134-135	6 -29	18	2 -14	8	6 -26	16
11 - 12	10 - 11	9 - 10	132-133	3 -26	11	0.9-12	4	2 -23	10
9 - 10	8 - 9	7 - 8	130-131	2 -18	6	0.4- 8	2	2 -16	6
8	7	5 - 6	128-129	0.6-11	3	0.2- 4	0.9	1 -10	2
6 - 7	5 - 6	3 - 4	126-127	0.2- 6	2	0.1- 2	0.4	1 - 6	2
4 - 5	3 - 4	1 - 2	124-125	0.2- 3	0.6	0.1- 0.9	0.2	0.9- 2	1
2 - 3	1 - 2	0	122-123	0.1- 2	0.2			0.1- 2	1
0 - 1	0		120-121	0.1- 0.6	0.2			0.1- 1	0.9

	Grade 7	Grade 8	Grade 9
Number of Students	1593	1675	1325
Number of Schools	54	55	48
Mean	145.	150	144
Standard Deviation	10	10	9
Upper Quartile	151	159	151
Median	144	151	145
Lower Quartile	137	142	138
SCAT-Q Mean	281	292	284
SCAT-Q Standard Deviation	19	20	16

TABLE 30. Structure of the Number System: National Norms

Raw Score		Converted Score	Grade 7		Grade 8	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
40		180-181				
39		178-179				
37 - 38	39 - 40	176-177				
36	38	174-175			97 -99.9	99.8
35	37	172-173			96 -99.9	99
33 - 34	35 - 36	170-171	98 -99.9	99.5	93 -99.8	97
32	34	168-169	97 -99.9	99.2	91 -99	96
31	32 - 33	166-167	96 -99.5	98	87 -97	93
29 - 30	31	164-165	94 -99.2	97	85 -96	91
28	29 - 30	162-163	93 -98	96	82 -93	87
26 - 27	28	160-161	88 -97	94	73 -91	85
25	27	158-159	85 -96	93	66 -87	82
24	25 - 26	156-157	80 -94	88	57 -85	73
22 - 23	24	154-155	77 -93	85	53 -82	66
21	22 - 23	152-153	72 -88	80	48 -73	57
19 - 20	21	150-151	64 -85	77	39 -66	53
18	19 - 20	148-149	53 -80	72	31 -57	48
17	18	146-147	39 -77	64	22 -53	39
15 - 16	17	144-145	34 -72	53	18 -48	31
14	15 - 16	142-143	29 -64	39	14 -39	22
12 - 13	14	140-141	16 -53	34	9 -31	18
11	12 - 13	138-139	12 -39	29	5 -22	14
10	11	136-137	8 -34	16	4 -18	9
8 - 9	10	134-135	2 -29	12	2 -14	5
7	8 - 9	132-133	1 -16	8	0.4- 9	4
5 - 6	7	130-131	0.1-12	2	0.1- 5	2
4	5 - 6	128-129	0.1- 8	1	0.1- 4	0.4
3	4	126-127				
1 - 2	2 - 3	124-125				
0	1	122-123				
	0	120-121				

	Grade 7	Grade 8
Number of Students	579	506
Number of Schools	21	17
Mean	145	150
Standard Deviation	9	10
Upper Quartile	150	157
Median	144	150
Lower Quartile	138	143
SCAT-Q Mean	291	298
SCAT-Q Standard Deviation	15	16

TABLE 31. Algebra I: National Norms

Raw Score		Converted Score	Grade 8		Grade 9	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
40	40	176-177				
39	38 - 39	174-175	99 -99.9	99.8		
37 - 38	37	172-173	97 -99.9	99.4	97 -99.9	99.6
36	35 - 36	170-171	95 -99.8	99	96 -99.9	99.2
35	34	168-169	90 -99.4	97	93 -99.6	97
33 - 34	32 - 33	166-167	87 -99	95	89 -99.2	96
32	31	164-165	83 -97	90	87 -97	93
30 - 31	29 - 30	162-163	73 -95	87	79 -96	89
29	28	160-161	68 -90	83	75 -93	87
27 - 28	26 - 27	158-159	56 -87	73	66 -89	79
26	25	156-157	49 -83	68	60 -87	75
25	24	154-155	39 -73	56	48 -79	66
23 - 24	22 - 23	152-153	33 -68	49	42 -75	60
22	21	150-151	29 -56	39	36 -66	48
20 - 21	19 - 20	148-149	18 -49	33	27 -60	42
19	18	146-147	14 -39	29	23 -48	36
17 - 18	16 - 17	144-145	8 -33	18	15 -42	27
16	15	142-143	6 -29	14	13 -36	23
15	13 - 14	140-141	3 -18	8	8 -27	15
13 - 14	12	138-139	2 -14	6	6 -23	13
12	10 - 11	136-137	2 - 8	3	4 -15	8
10 - 11	9	134-135	1 - 6	2	2 -13	6
9	8	132-133	0.7- 3	2	1 - 8	4
7 - 8	6 - 7	130-131	0.5- 2	1	0.6- 6	2
6	5	128-129	0.5- 2	0.7	0.5- 4	1
5	3 - 4	126-127	0.3- 1	0.5	0.4- 2	0.6
3 - 4	2	124-125	0.2- 0.7	0.5	0.4- 1	0.5
2	0 - 1	122-123	0.1- 0.5	0.3	0.1- 0.6	0.4
0 - 1		120-121	0.1- 0.5	0.2	0.1- 0.5	0.4

Number of Students	850	3271
Number of Schools	32	121
Mean	152	150
Standard Deviation	9	10
Upper Quartile	159	157
Median	153	150
Lower Quartile	146	144
SCAT-Q Mean	306	301
SCAT-Q Standard Deviation	13	15

TABLE 32. Algebra I: Urban Norms

Raw Score		Converted Score	Grade 8		Grade 9	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
40	40	176-177				
39	38 - 39	174-175	98 -99.9	99.6		
37 - 38	37	172-173	96 -99.9	99	98 -99.9	99.5
36	35 - 36	170-171	95 -99.6	98	96 -99.9	99.3
35	34	168-169	93 -99	96	93 -99.5	98
33 - 34	32 - 33	166-167	91 -98	95	90 -99.3	96
32	31	164-165	87 -96	93	87 -98	93
30 - 31	29 - 30	162-163	80 -95	91	79 -96	90
29	28	160-161	75 -93	87	75 -93	87
27 - 28	26 - 27	158-159	63 -91	80	67 -90	79
26	25	156-157	56 -87	75	63 -87	75
25	24	154-155	46 -80	63	52 -79	67
23 - 24	22 - 23	152-153	39 -75	56	47 -75	63
22	21	150-151	34 -63	46	42 -67	52
20 - 21	19 - 20	148-149	22 -56	39	33 -63	47
19	18	146-147	20 -46	34	28 -52	42
17 - 18	16 - 17	144-145	14 -39	22	19 -47	33
16	15	142-143	11 -34	20	15 -42	28
15	13 - 14	140-141	6 -22	14	10 -33	19
13 - 14	12	138-139	5 -20	11	8 -28	15
12	10 - 11	136-137	4 -14	6	5 -19	10
10 - 11	9	134-135	3 -11	5	2 -15	8
9	8	132-133	1 - 6	4	2 -10	5
7 - 8	6 - 7	130-131	0.8- 5	3	1 - 8	2
6	5	128-129	0.8- 4	1	1 - 5	2
5	3 - 4	126-127	0.8- 3	0.8	1.0- 2	1
3 - 4	2	124-125	0.6- 1	0.8	0.8- 2	1
2	0 - 1	122-123	0.1- 0.8	0.8	0.1- 1	1.0
0 - 1		120-121	0.1- 0.8	0.6	0.1- 1	0.8
Number of Students			461		1668	
Number of Schools			17		60	
Mean			151		149	
Standard Deviation			10		10	
Upper Quartile			157		157	
Median			151		149	
Lower Quartile			145		142	
SCAT-Q Mean			304		299	
SCAT-Q Standard Deviation			14		16	

TABLE 33. Algebra II: National and Urban High School Norms

Raw Score		Converted Score	National		Urban	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
40	40	176-177			99.0-99.9	99.9
38 - 39	38 - 39	174-175	98 -99.9	99.7	98 -99.9	99.6
37	37	172-173	97 -99.9	99.2	97 -99.9	99.0
35 - 36	35 - 36	170-171	95 -99.7	98	94 -99.6	98
34	34	168-169	93 -99.2	97	93 -99.0	97
32 - 33	32 - 33	166-167	88 -98	95	88 -98	94
31	31	164-165	85 -97	93	85 -97	93
30	29 - 30	162-163	79 -95	88	78 -94	88
28 - 29	28	160-161	75 -93	85	75 -93	85
27	26 - 27	158-159	67 -88	79	66 -88	78
25 - 26	25	156-157	59 -85	75	60 -85	75
24	23 - 24	154-155	48 -79	67	48 -78	66
22 - 23	22	152-153	43 -75	59	44 -75	60
21	20 - 21	150-151	38 -67	48	39 -66	48
19 - 20	19	148-149	29 -59	43	29 -60	44
18	17 - 18	146-147	25 -48	38	26 -48	39
16 - 17	16	144-145	17 -43	29	18 -44	29
15	14 - 15	142-143	14 -38	25	16 -39	26
13 - 14	13	140-141	8 -29	17	11 -29	18
12	11 - 12	138-139	7 -25	14	8 -26	16
11	10	136-137	3 -17	8	4 -18	11
9 - 10	8 - 9	134-135	2 -14	7	3 -16	8
8	7	132-133	1 - 8	3	2 -11	4
6 - 7	5 - 6	130-131	1 - 7	2	1 - 8	3
5	4	128-129	1 - 3	1	1 - 4	2
3 - 4	2 - 3	126-127	0.6- 2	1	0.8- 3	1
2	1	124-125	0.1- 1	1	0.1- 2	1
0 - 1	0	122-123	0.1- 1	0.6	0.1- 1	0.8
Number of Students			2809		1571	
Number of Schools			114		56	
Mean			150		150	
Standard Deviation			10		10	
Upper Quartile			157		157	
Median			150		150	
Lower Quartile			143		143	
SCAT-Q Mean			309		308	
SCAT-Q Standard Deviation			15		15	

TABLE 34. Geometry: National High School Norms

Total (Parts I & II)

Raw Score Form A	Raw Score Form B	Converted Score	Percentile Band	Mid-Percentile Rank
79 - 80		188-189		
77 - 78		186-187		
75 - 76	80	184-185		
73 - 74	77,78 - 79	182-183		
70 - 71,72	75 - 76	180-181	99.5-99.9	99.9
68 - 69	73 - 74	178-179	99.2-99.9	99.7
66 - 67	70 - 71,72	176-177	99 -99.9	99.5
64 - 65	68 - 69	174-175	98 -99.7	99.2
62 - 63	66 - 67	172-173	97 -99.5	99
60 - 61	63 - 64,65	170-171	95 -99.2	98
58 - 59	61 - 62	168-169	93 -99	97
56 - 57	58,59 - 60	166-167	89 -98	95
54 - 55	56 - 57	164-165	85 -97	93
52 - 53	54 - 55	162-163	80 -95	89
50 - 51	51 - 52,53	160-161	75 -93	85
48 - 49	49 - 50	158-159	67 -89	80
46 - 47	47 - 48	156-157	60 -85	75
44 - 45	44 - 45,46	154-155	51 -80	67
42 - 43	42 - 43	152-153	43 -75	60
40 - 41	39,40 - 41	150-151	35 -67	51
38 - 39	37 - 38	148-149	27 -60	43
36 - 37	35 - 36	146-147	22 -51	35
34 - 35	32 - 33,34	144-145	17 -43	27
32 - 33	30 - 31	142-143	12 -35	22
30 - 31	27,28 - 29	140-141	9 -27	17
28 - 29	25 - 26	138-139	7 -22	12
26 - 27	23 - 24	136-137	4 -17	9
24 - 25	20,21 - 22	134-135	3 -12	7
22 - 23	18 - 19	132-133	2 - 9	4
20 - 21	16 - 17	130-131	2 - 7	3
18 - 19	13 - 14,15	128-129	1 - 4	2
16 - 17	11 - 12	126-127	0.5- 3	2
14 - 15	8,9 - 10	124-125	0.3- 2	1
12 - 13	6 - 7	122-123	0.2- 2	0.5
10 - 11	4 - 5	120-121	0.2- 1	0.3
8 - 9	1,2 - 3	118-119	0.1- 0.5	0.2
6 - 7	0	116-117	0.1- 0.3	0.2
4 - 5		114-115	0.1- 0.2	0.1
2 - 3		112-113		
0,1		110-111		

Number of Students	3303
Number of Schools	129
Mean	150
Standard Deviation	10
Upper Quartile	156
Median	150
Lower Quartile	144
SCAT-Q Mean	303
SCAT-Q Standard Deviation	14

Part I Only

Raw Score Form A	Raw Score Form B	Converted Score	Percentile Band	Mid-Percentile Rank
39 - 40	40	174-175		
38	39	172-173	98 -99.9	99.7
37	37 - 38	170-171	96 -99.9	99.3
36	36	168-169	94 -99.7	99
35	34 - 35	166-167	87 -99.3	96
34	33	164-165	83 -99	94
32 - 33	32	162-163	77 -98	91
31	30 - 31	160-161	72 -96	87
30	29	158-159	64 -94	83
29	27 - 28	156-157	50 -87	72
28	26	154-155	43 -83	64
26 - 27	25	152-153	37 -77	57
25	23 - 24	150-151	31 -72	50
24	22	148-149	24 -64	43
23	20 - 21	146-147	16 -50	31
22	19	144-145	13 -43	24
20 - 21	18	142-143	11 -37	20
19	16 - 17	140-141	8 -31	16
18	15	138-139	6 -24	13
17	13 - 14	136-137	4 -16	8
16	12	134-135	3 -13	6
14 - 15	10 - 11	132-133	2 -11	6
13	9	130-131	2 - 8	4
12	8	128-129	1 - 6	3
11	6 - 7	126-127	1.0- 4	2
10	5	124-125	0.7- 3	1
9	3 - 4	122-123	0.3- 2	1.0
7 - 8	2	120-121	0.2- 2	0.8
6	1	118-119	0.2- 1	0.7
5	0	116-117	0.2- 1.0	0.3
4		114-115	0.2- 0.7	0.2
3		112-113	0.1- 0.3	0.2
1 - 2		110-111	0.1- 0.2	0.2
0		108-109	0.1- 0.2	0.2

Number of Students	3303
Number of Schools	129
Mean	150
Standard Deviation	10
Upper Quartile	157
Median	151
Lower Quartile	144
SCAT-Q Mean	303
SCAT-Q Standard Deviation	14

TABLE 35. Geometry: Urban High School Norms

Total (Parts I & II)

Raw Score		Converted Score	Percentile Band	Mid-Percentile Rank
Form A	Form B			
79 - 80		188-189		
77 - 78		186-187		
75 - 76	80	184-185		
73 - 74	77,78 - 79	182-183		
70 - 71,72	75 - 76	180-181	99.1-99.9	99.8
68 - 69	73 - 74	178-179	99 -99.9	99.6
66 - 67	70 - 71,72	176-177	98 -99.8	99.1
64 - 65	68 - 69	174-175	97 -99.6	99
62 - 63	66 - 67	172-173	96 -99.1	98
60 - 61	63 - 64,65	170-171	94 -99	97
58 - 59	61 - 62	168-169	92 -98	96
56 - 57	58,59 - 60	166-167	89 -97	94
54 - 55	56 - 57	164-165	85 -96	92
52 - 53	54 - 55	162-163	81 -94	89
50 - 51	51 - 52,53	160-161	76 -92	85
48 - 49	49 - 50	158-159	67 -89	81
46 - 47	47 - 48	156-157	60 -85	76
44 - 45	44 - 45,46	154-155	51 -81	67
42 - 43	42 - 43	152-153	44 -76	60
40 - 41	39,40 - 41	150-151	37 -67	51
38 - 39	37 - 38	148-149	28 -60	44
36 - 37	35 - 36	146-147	23 -51	37
34 - 35	32 - 33,34	144-145	17 -44	28
32 - 33	30 - 31	142-143	12 -37	23
30 - 31	27,28 - 29	140-141	8 -28	17
28 - 29	25 - 26	138-139	6 -23	12
26 - 27	23 - 24	136-137	4 -17	8
24 - 25	20,21 - 22	134-135	3 -12	6
22 - 23	18 - 19	132-133	2 - 8	4
20 - 21	16 - 17	130-131	1 - 6	3
18 - 19	13 - 14,15	128-129	1 - 4	2
16 - 17	11 - 12	126-127	0.8- 3	1
14 - 15	8,9 - 10	124-125	0.6- 2	1
12 - 13	6 - 7	122-123	0.4- 1	0.8
10 - 11	4 - 5	120-121	0.4- 1	0.6
8 - 9	1,2 - 3	118-119	0.2- 0.8	0.4
6 - 7	0	116-117	0.1- 0.6	0.4
4 - 5		114-115	0.1- 0.4	0.2
2 - 3		112-113	0.1- 0.4	0.1
0,1		110-111		

Number of Students	1693
Number of Schools	63
Mean	150
Standard Deviation	10
Upper Quartile	156
Median	150
Lower Quartile	143
SCAT-Q Mean	302
SCAT-Q Standard Deviation	14

Part I Only

Raw Score		Converted Score	Percentile Band	Mid-Percentile Rank
Form A	Form B			
39 - 40	40	174-175		
38	39	172-173	97 -99.9	99.8
37	37 - 38	170-171	96 -99.9	99.0
36	36	168-169	94 -99.8	98
35	34 - 35	166-167	86 -99.0	96
34	33	164-165	83 -98	94
32 - 33	32	162-163	77 -97	90
31	30 - 31	160-161	72 -96	86
30	29	158-159	64 -94	83
29	27 - 28	156-157	49 -86	72
28	26	154-155	42 -83	64
26 - 27	25	152-153	36 -77	57
25	23 - 24	150-151	30 -72	49
24	22	148-149	23 -64	42
23	20 - 21	146-147	16 -49	30
22	19	144-145	13 -42	23
20 - 21	18	142-143	11 -36	19
19	16 - 17	140-141	8 -30	16
18	15	138-139	7 -23	13
17	13 - 14	136-137	4 -16	8
16	12	134-135	3 -13	7
14 - 15	10 - 11	132-133	2 -11	6
13	9	130-131	2 - 8	4
12	8	128-129	1 - 7	3
11	6 - 7	126-127	1 - 4	2
10	5	124-125	1.0- 3	1
9	3 - 4	122-123	0.6- 2	1
7 - 8	2	120-121	0.4- 2	1.0
6	1	118-119	0.4- 1	1.0
5	0	116-117	0.3- 1	0.6
4		114-115	0.3- 1.0	0.4
3		112-113	0.1- 0.6	0.3
1 - 2		110-111	0.1- 0.4	0.3
0		108-109	0.1- 0.4	0.3

Number of Students	1693
Number of Schools	63
Mean	150
Standard Deviation	10
Upper Quartile	157
Median	151
Lower Quartile	145
SCAT-Q Mean	302
SCAT-Q Standard Deviation	14

TABLE 36. Trigonometry: National and Urban High School Norms and Algebra III: National High School Norms

Trigonometry

Raw Score		Converted Score	National		Urban	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
39 - 40		190-191				
38		188-189				
37	40	186-187	99.0-99.9	99.7		
36	39	184-185	99 -99.9	99.7		
34 - 35	37 - 38	182-183	99 -99.7	99.5	99.3-99.9	99.8
33	36	180-181	98 -99.7	99.0	99 -99.9	99.8
32	35	178-179	98 -99.7	99	98 -99.9	99.6
31	33 - 34	176-177	97 -99.0	98	97 -99.8	99
30	32	174-175	96 -99	98	96 -99.6	98
28 - 29	31	172-173	94 -99	97	94 -99.3	97
27	29 - 30	170-171	93 -98	97	92 -99	97
26	28	168-169	91 -98	96	91 -98	96
25	27	166-167	86 -97	93	86 -97	92
24	25 - 26	164-165	83 -96	91	83 -96	91
22 - 23	24	162-163	79 -94	89	79 -94	90
21	22 - 23	160-161	76 -93	86	75 -92	86
20	21	158-159	66 -91	79	65 -91	79
19	20	156-157	60 -86	76	60 -86	75
17 - 18	18 - 19	154-155	54 -83	72	54 -83	70
16	17	152-153	48 -79	66	47 -79	65
15	16	150-151	38 -76	60	38 -75	60
14	14 - 15	148-149	24 -66	48	25 -65	47
13	13	146-147	19 -60	38	18 -60	38
11 - 12	12	144-145	13 -54	32	13 -54	33
10	10 - 11	142-143	9 -48	24	9 -47	25
9	9	140-141	5 -38	19	5 -38	18
8	8	138-139	2 -24	9	2 -25	9
7	6 - 7	136-137	0.7-19	5	0.6-18	5
5 - 6	5	134-135	0.5-13	3	0.6-13	3
4	3 - 4	132-133	0.3- 9	2	0.2- 9	2
3	2	130-131	0.1- 5	0.5	0.1- 5	0.6
2	1	128-129	0.1- 2	0.3	0.1- 2	0.2
0 - 1	0	126-127			0.1- 0.6	0.1

	National	Urban
Number of Students	1536	908
Number of Schools	77	41
Mean	150	150
Standard Deviation	10	10
Upper Quartile	156	156
Median	148	149
Lower Quartile	143	143
SCAT-Q Mean	316	315
SCAT-Q Standard Deviation	15	13

Algebra III

Raw Score		Converted Score	National	
Form A	Form B		Percentile Band	Mid-Percentile Rank
40		186-187		
39	39 - 40	184-185		
38	38	182-183	97 -99.9	99.8
36 - 37	37	180-181	96 -99.9	99
35	36	178-179	92 -99.9	98
34	35	176-177	90 -99.8	96
32 - 33	33 - 34	174-175	87 -98	95
31	32	172-173	82 -97	92
30	31	170-171	73 -96	90
29	30	168-169	68 -92	82
27 - 28	29	166-167	62 -90	79
26	27 - 28	164-165	54 -87	73
25	26	162-163	47 -82	62
23 - 24	25	160-161	40 -73	54
22	24	158-159	32 -68	54
21	22 - 23	156-157	20 -62	40
20	21	154-155	16 -54	32
18 - 19	20	152-153	13 -47	27
17	19	150-151	7 -40	20
16	18	148-149	4 -32	13
14 - 15	16 - 17	146-147	3 -20	10
13	15	144-145	1 -16	7
12	14	142-143	0.8-13	3
10 - 11	13	140-141	0.3- 7	1
9	11 - 12	138-139	0.1- 4	1
8	10	136-137	0.1- 3	0.8
7	9	134-135		
5 - 6	8	132-133		
4	7	130-131		
3	5 - 6	128-129		
1 - 2	4	126-127		
0	3	124-125		
	2	122-123		
	1	120-121		
	0	118-119		

	National
Number of Students	813
Number of Schools	35
Mean	159
Standard Deviation	9
Upper Quartile	166
Median	158
Lower Quartile	152
SCAT-Q Mean	324
SCAT-Q Standard Deviation	9

TABLE 37. Trigonometry: College Norms

Raw Score		Converted Score	National		Education		Engineering		Liberal Arts	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
39 - 40		190-191								
38		188-189								
37	40	186-187								
36	39	184-185								
34 - 35	37 - 38	182-183	99.6-99.9	99.9	99.4-99.9	99.4				
33	36	180-181	99.4-99.9	99.9	99.4-99.9	99.4				
32	35	178-179	99 -99.9	99.8	99 -99.9	99.4			98 -99.9	99.7
31	33 - 34	176-177	98 -99.9	99.4	97 -99.4	99.4			98 -99.9	99
30	32	174-175	97 -99.8	99	96 -99.4	99	98 -99.9	99.6	97 -99.7	98
28 - 29	31	172-173	96 -99.6	99	96 -99.4	98	98 -99.9	99.6	95 -99.0	98
27	29 - 30	170-171	95 -99.4	98	95 -99.4	97	96 -99.9	99.6	93 -99	98
26	28	168-169	94 -99	97	92 -99	96	95 -99.6	98	92 -98	97
25	27	166-167	88 -98	95	88 -97	95	88 -99.6	96	86 -98	93
24	25 - 26	164-165	85 -97	94	85 -96	92	83 -98	95	83 -97	92
22 - 23	24	162-163	81 -96	92	83 -96	91	79 -98	93	78 -95	90
21	22 - 23	160-161	77 -95	88	78 -95	88	73 -96	88	74 -93	86
20	21	158-159	67 -94	81	73 -92	83	60 -95	79	63 -92	78
19	20	156-157	61 -88	77	67 -88	78	55 -88	73	58 -86	74
17 - 18	18 - 19	154-155	54 -85	72	61 -85	75	49 -83	66	52 -83	69
16	17	152-153	48 -81	67	54 -83	73	44 -79	60	46 -78	63
15	16	150-151	39 -77	61	43 -78	67	33 -73	55	35 -74	58
14	14 - 15	148-149	25 -67	48	30 -73	54	24 -60	44	21 -63	46
13	13	146-147	18 -61	39	23 -67	43	18 -55	33	15 -58	35
11 - 12	12	144-145	13 -54	32	19 -61	37	13 -49	28	11 -52	28
10	10 - 11	142-143	9 -48	25	13 -54	30	7 -44	24	9 -46	21
9	9	140-141	5 -39	18	9 -43	23	3 -33	18	5- 35	15
8	8	138-139	1 -25	9	3 -30	13	0.4-24	7	1 -21	9
7	6 - 7	136-137	0.6-18	5	0.6-23	9	0.1-18	3	0.3-15	5
5 - 6	5	134-135	0.3-13	3	0.1-19	6	0.1-13	2	0.3-11	3
4	3 - 4	132-133	0.1- 9	1	0.1-13	3	0.1- 7	0.4	0.3- 9	1
3	2	130-131	0.1- 5	0.3					0.1- 5	0.3
2	1	128-129	0.1- 1	0.1					0.1- 1	0.3
0 - 1	0	126-127								

	National	Education	Engineering	Liberal Arts
Number of Students	1266	171	242	312
Number of Schools	60	45	42	48
Mean	150	148	150	150
Standard Deviation	9	10	9	9
Upper Quartile	156	155	157	156
Median	148	147	150	149
Lower Quartile	143	142	143	144
SCAT-Q Mean	313	314	312	316
SCAT-Q Standard Deviation	13	12	13	11

TABLE 38. Algebra III: College Norms

Raw Score		Converted Score	National		Education		Engineering		Liberal Arts	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
40		186-187								
39	39 - 40	184-185								
38	38	182-183	99.5-99.9	99.9					98 -99.9	99.6
36 - 37	37	180-181	99.2-99.9	99.9					97 -99.9	99.6
35	36	178-179	99 -99.9	99.6					96 -99.9	98
34	35	176-177	98 -99.9	99.2					96 -99.6	97
32 - 33	33 - 34	174-175	97 -99.6	99.1					94 -98	97
31	32	172-173	96 -99.5	99					91 -98	96
30	31	170-171	93 -99.2	98			91 -99.9	99	88 -97	96
29	30	168-169	91 -99	96	95 -99.9	99.2	88 -99.9	96	85 -96	91
27 - 28	29	166-167	87 -98	94	91 -99.9	96	83 -99	94	80 -96	90
26	27 - 28	164-165	83 -97	93	87 -99.9	96	76 -97	91	76 -94	88
25	26	162-163	78 -96	87	81 -99.2	91	71 -96	83	71 -91	80
23 - 24	25	160-161	73 -93	85	76 -96	87	63 -91	80	66 -88	77
22	24	158-159	67 -91	83	69 -95	87	56 -88	76	62 -85	76
21	22 - 23	156-157	54 -87	73	55 -91	76	45 -83	63	49 -80	66
20	21	154-155	50 -83	67	49 -87	69	41 -76	56	44 -76	62
18 - 19	20	152-153	44 -78	61	45 -81	64	35 -71	50	39 -71	56
17	19	150-151	32 -73	54	34 -76	55	28 -63	45	28 -66	49
16	18	148-149	26 -67	44	26 -69	45	26 -56	35	22 -62	39
14 - 15	16 - 17	146-147	22 -54	38	23 -55	39	21 -45	31	19 -49	35
13	15	144-145	14 -50	32	16 -49	34	12 -41	28	10 -44	28
12	14	142-143	11 -44	22	13 -45	23	9 -35	21	8 -39	19
10 - 11	13	140-141	7 -32	18	8 -34	19	8 -28	15	4 -28	13
9	11 - 12	138-139	4 -26	14	4 -26	16	3 -26	12	3 -22	10
8	10	136-137	2 -22	11	3 -23	13	1 -21	9	2 -19	8
7	9	134-135	1.0-14	11	3 -16	4	0.5-12	3	0.8-10	3
5 - 6	8	132-133	0.7-11	3	3 -13	3	0.5- 9	3	0.4- 8	2
4	7	130-131	0.2- 7	2	0.8- 8	3	0.5- 8	1	0.1- 4	2
3	5 - 6	128-129	0.1- 4	0.7	0.1- 4	3	0.5- 3	0.5	0.1- 3	0.4
1 - 2	4	126-127	0.1- 2	0.3	0.1- 3	0.8	0.5- 1	0.5	0.1- 2	0.4
0	3	124-125	0.1- 1.0	0.2	0.1- 3	0.8	0.1- 0.5	0.5		
	2	122-123	0.1- 0.7	0.1			0.1- 0.5	0.5		
	1	120-121								
	0	118-119								

	National	Education	Engineering	Liberal Arts
Number of Students	1008	118	201	239
Number of Schools	49	36	39	39
Mean	150	149	152	152
Standard Deviation	10	9	10	11
Upper Quartile	157	156	159	159
Median	150	150	153	151
Lower Quartile	143	143	143	144
SCAT-Q Mean	313	313	313	314
SCAT-Q Standard Deviation	14	14	14	14

TABLE 39. Analytic Geometry and Calculus: National High School Norms

Analytic Geometry					Calculus				
Raw Score		Converted Score	Percentile Band	Mid-Percentile Rank	Raw Score		Converted Score	Percentile Band	Mid-Percentile Rank
Form A	Form B				Form A	Form B			
						60	188-189		
						58 - 59	186-187		
	35	184-185				56 - 57	184-185		
35	34	182-183	96 -99.9	99.5	59 - 60	54 - 55	182-183	97 -99.9	99
33 - 34	33	180-181	95 -99.9	99	57 - 58	53	180-181	94 -99.9	97
32	32	178-179	95 -99.9	98	55 - 56	51 - 52	178-179	91 -99	97
31	31	176-177	92 -99.5	96	53 - 54	49 - 50	176-177	88 -97	94
30	30	174-175	92 -98	95	51 - 52	48	174-175	86 -97	91
29	29	172-173	90 -96	95	50	46 - 47	172-173	82 -94	88
28	28	170-171	86 -95	92	48 - 49	44 - 45	170-171	76 -91	86
27	27	168-169	79 -95	92	46 - 47	43	168-169	72 -88	82
26	26	166-167	74 -92	90	44 - 45	41 - 42	166-167	62 -86	76
25	25	164-165	70 -92	79	42 - 43	39 - 40	164-165	55 -82	72
24	24	162-163	64 -90	74	40 - 41	38	162-163	49 -76	62
23	23	160-161	57 -86	70	38 - 39	36 - 37	160-161	44 -72	55
22	22	158-159	52 -79	64	36 - 37	34 - 35	158-159	38 -62	49
21	21	156-157	46 -74	57	34 - 35	33	156-157	31 -55	44
20	20	154-155	32 -70	52	32 - 33	31 - 32	154-155	27 -49	38
19	19	152-153	25 -64	46	30 - 31	29 - 30	152-153	20 -44	31
17 - 18	17 - 18	150-151	19 -57	39	28 - 29	28	150-151	17 -38	27
16	16	148-149	15 -52	32	27	26 - 27	148-149	10 -31	20
15	15	146-147	10 -46	25	25 - 26	24 - 25	146-147	8 -27	17
14	14	144-145	7 -32	19	23 - 24	23	144-145	6 -20	10
13	13	142-143	5 -25	15	21 - 22	21 - 22	142-143	4 -17	8
12	12	140-141	4 -19	10	19 - 20	19 - 20	140-141	2 -10	6
11	11	138-139	2 -15	7	17 - 18	18	138-139	0.2- 8	4
10	10	136-137	2 -10	5	15 - 16	16 - 17	136-137	0.2- 6	2
9	9	134-135	1 - 7	2	14 - 15	14 - 15	134-135	0.1- 4	0.2
8	8	132-133	[illegible]	[illegible]	[illegible]	13	132-133	[illegible]	[illegible]
7	7	130-131	0.2- 4	1	9 - 10	11 - 12	130-131		
6	6	128-129	0.1- 2	1	7 - 8	9 - 10	128-129		
5	5	126-127	0.1- 2	0.2	5 - 6	8	126-127		
4	4	124-125			4	6 - 7	124-125		
3	3	122-123			2 - 3	4 - 5	122-123		
1 - 2	2	120-121			0 - 1	2 - 3	120-121		
0	1	118-119				1	118-119		
	0	116-117				0	116-117		

	Analytic Geometry		Calculus
Number of Students	403	Number of Students	168
Number of Schools	22	Number of Schools	9
Mean	154	Mean	158
Standard Deviation	11	Standard Deviation	11
Upper Quartile	162	Upper Quartile	166
Median	154	Median	159
Lower Quartile	147	Lower Quartile	149
SCAT-Q Mean	326	SCAT-Q Mean	332
SCAT-Q Standard Deviation	9	SCAT-Q Standard Deviation	7

TABLE 40. Analytic Geometry: College Norms

Raw Score		Converted Score	National		Education		Engineering		Liberal Arts	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
	35	184-185								
35	34	182-183								
33 - 34	33	180-181	99.2-99.9	99.7			99.3-99.9	99.7	98 -99.9	99.7
32	32	178-179	99 -99.9	99.6			98 -99.9	99.7	98 -99.9	99.3
31	31	176-177	97 -99.9	99.6			98 -99.9	99.7	95 -99.9	99.3
30	30	174-175	97 -99.6	99.2			97 -99.7	99.3	95 -99.3	98
29	29	172-173	96 -99.6	99			96 -99.7	98	92 -99.3	98
28	28	170-171	94 -99.2	97	97 -99.9	99.1	94 -99.3	98	90 -98	95
27	27	168-169	92 -99	97	95 -99.9	99.1	91 -98	97	88 -98	95
26	26	166-167	88 -97	96	92 -99.1	99.1	88 -98	96	84 -95	92
25	25	164-165	83 -97	92	89 -99.1	95	82 -97	91	78 -95	88
24	24	162-163	79 -96	88	83 -99.1	92	78 -96	88	75 -92	84
23	23	160-161	73 -94	83	77 -97	89	71 -94	82	70 -90	78
22	22	158-159	66 -92	79	72 -95	83	65 -91	78	64 -88	75
21	21	156-157	59 -88	73	66 -92	77	58 -88	71	57 -84	70
20	20	154-155	45 -83	66	50 -89	72	45 -82	65	43 -78	64
19	19	152-153	39 -79	59	44 -83	66	37 -78	58	38 -75	57
17 - 18	17 - 18	150-151	31 -73	52	34 -77	60	31 -71	50	28 -70	50
16	16	148-149	24 -66	45	28 -72	50	24 -65	45	22 -64	43
15	15	146-147	19 -59	39	23 -66	44	18 -58	37	16 -57	38
14	14	144-145	14 -45	31	16 -50	34	14 -45	31	12 -43	28
13	13	142-143	10 -39	24	10 -44	28	12 -37	24	7 -38	22
12	12	140-141	8 -31	19	7 -34	23	11 -31	18	4 -28	16
11	11	138-139	5 -24	14	4 -28	16	8 -24	14	2 -22	12
10	10	136-137	3 -19	10	1 -23	10	4 -18	12	2 -16	7
9	9	134-135	1 -14	5	0.9-16	4	2 -14	8	0.4-12	2
8	8	132-133	1 -10	3	0.5-10	1	2 -12	4	0.4- 7	2
7	7	130-131	0.5- 8	1	0.5- 7	0.9	0.7-11	2	0.4- 4	0.4
6	6	128-129	0.2- 5	1	0.1- 4	0.5	0.7- 8	2	0.1- 2	0.4
5	5	126-127	0.1- 3	0.5	0.1- 1	0.5	0.1- 4	0.7	0.1- 2	0.4
4	4	124-125	0.1- 1	0.2			0.1- 2	0.7		
3	3	122-123								
1 - 2	2	120-121								
0	1	118-119								
	0	116-117								
Number of Students			1113		213		285		288	
Number of Schools			49		37		37		35	
Mean			150		149		150		151	
Standard Deviation			10		9		10		10	
Upper Quartile			157		155		157		158	
Median			150		149		150		151	
Lower Quartile			143		142		143		144	
SCAT-Q Mean			320		321		317		322	
SCAT-Q Standard Deviation			12		10		14		11	

TABLE 41. Calculus: College Norms

Raw Score		Converted Score	National		Education		Engineering		Liberal Arts	
Form A	Form B		Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank	Percentile Band	Mid-Percentile Rank
	60	188-189								
	58 - 59	186-187	99.9-99.9	99.9	99.5-99.9	99.5				
	56 - 57	184-185	99.6-99.9	99.9	99.5-99.9	99.5				
59 - 60	54 - 55	182-183	99.5-99.9	99.9	99.5-99.5	99.5				
57 - 58	53	180-181	99.1-99.9	99.6	99.5-99.5	99.5	98 -99.9	99.2		
55 - 56	51 - 52	178-179	98 -99.9	99.5	99 -99.5	99.5	98 -99.9	99.2	99.5-99.9	99.7
53 - 54	49 - 50	176-177	98 -99.6	99.1	99 -99.5	99.5	98 -99.2	98	99.5-99.9	99.7
51 - 52	48	174-175	97 -99.5	98	98 -99.5	99	96 -99.2	98	98 -99.7	99.5
50	46 - 47	172-173	96 -99.1	98	96 -99.5	99	96 -98	98	98 -99.7	99.5
48 - 49	44 - 45	170-171	94 -98	97	95 -99	98	94 -98	96	95 -99.5	98
46 - 47	43	168-169	92 -98	96	93 -99	96	91 -98	96	93 -99.5	98
44 - 45	41 - 42	166-167	89 -97	94	89 -98	95	88 -96	94	90 -98	95
42 - 43	39 - 40	164-165	85 -96	92	87 -96	93	85 -96	91	86 -98	93
40 - 41	38	162-163	80 -94	89	83 -95	89	80 -94	88	81 -95	90
38 - 39	36 - 37	160-161	76 -92	85	79 -93	87	77 -91	85	76 -93	86
36 - 37	34 - 35	158-159	70 -89	80	74 -89	83	69 -88	80	68 -90	81
34 - 35	33	156-157	60 -85	76	67 -87	79	61 -85	77	57 -86	76
32 - 33	31 - 32	154-155	54 -80	70	61 -83	74	54 -80	69	50 -81	68
30 - 31	29 - 30	152-153	43 -76	60	50 -79	67	46 -77	61	37 -76	57
28 - 29	28	150-151	39 -70	54	48 -74	61	42 -69	54	33 -68	50
27	26 - 27	148-149	31 -60	43	36 -67	50	36 -61	46	22 -57	37
25 - 26	24 - 25	146-147	24 -54	39	29 -61	48	31 -54	42	17 -50	33
23 - 24	23	144-145	18 -43	31	22 -50	36	21 -46	36	11 -37	22
21 - 22	21 - 22	142-143	12 -39	24	14 -48	29	17 -42	31	5 -33	17
19 - 20	19 - 20	140-141	8 -31	18	9 -36	22	13 -36	21	4 -22	11
17 - 18	18	138-139	5 -24	12	7 -29	14	8 -31	17	2 -17	5
15 - 16	16 - 17	136-137	2 -18	8	0.9-22	9	5 -21	13	0.5-11	4
13 - 14	14 - 15	134-135	0.9-12	5	0.1-14	7	2 -17	8	0.3- 5	2
11 - 12	13	132-133	0.5- 8	2	0.1- 9	0.9	2 -13	5	0.1- 4	0.5
9 - 10	11 - 12	130-131	0.2- 5	0.9			0.8- 8	2	0.1- 2	0.3
7 - 8	9 - 10	128-129	0.2- 2	0.5			0.5- 5	2		
5 - 6	8	126-127	0.2- 0.9	0.2			0.5- 2	0.8		
4	6 - 7	124-125	0.2- 0.5	0.2			0.5- 2	0.5		
2 - 3	4 - 5	122-123	0.1- 0.2	0.2			0.1- 0.8	0.5		
0 - 1	2 - 3	120-121	0.1- 0.2	0.2			0.1- 0.5	0.5		
	1	118-119								
	0	116-117								
Number of Students			1288		214		396		377	
Number of Schools			64		41		43		47	
Mean			150		149		149		151	
Standard Deviation			10		10		11		9	
Upper Quartile			156		155		156		156	
Median			149		148		149		150	
Lower Quartile			143		141		142		145	
SCAT-Q Mean			323		325		320		325	
SCAT-Q Standard Deviation			11		10		12		10	

COOPERATIVE
MATHEMATICS
TESTS

TECHNICAL REPORT

TECHNICAL REPORT

DEVELOPMENT OF THE TESTS

Initial planning for the Cooperative Mathematics series began in the spring of 1958 with consideration of (1) the appropriateness of existing tests and interpretive materials for current mathematics programs and students, (2) the situation of ferment and change in mathematics curricula and probable directions of change, and (3) the rising need for appropriate measurement instruments, both for assessing student achievement and for program evaluation.

Each of the older Cooperative Mathematics tests was submitted to five reviewers,* with a questionnaire requesting item-by-item evaluation as well as general criticism. An advisory committee of ten leaders in mathematics education was appointed to help weigh the reviews and to work with the ETS staff in developing specifications for the new series. When final agreement on the specifications was reached, 46 mathematics teachers, junior high school through college, were engaged to write the items. The nearly 2000 items that were produced were reviewed and edited by the ETS staff, and 46 pretest forms were assembled. Finally, each of the pretests was reviewed by four mathematics teachers.

The 46 pretest forms were administered to a national sample of students in May, 1960.** Analysis of the results revealed that the committees had been too optimistic about the mathematics training of American students; the tests were too difficult for the general school population.

Intensive revision of the Arithmetic, Algebra I, Algebra II, Geometry, and Trigonometry tests was undertaken immediately. Revision of many of the pretest items and the addition of many new items, guided by additional reviews and small experimental tryouts in selected schools, produced new forms which were administered to three school samples—suburban, rural, and urban—in May, 1961. Analysis of the results indicated that the tests were now appropriate in difficulty and discriminating power, and these tests were published with the data from the 1961 administration as temporary reference material.

The Algebra III, Analytic Geometry, Calculus, and Structure of the Number System tests were subsequently submitted to a similar intensive revision process, and the revised forms were re-pretested in a national program in May, 1962. The results indicated that these tests also were now appropriate for the intended populations.

The programs to equate the tests and to establish norms are described in the next sections of this report.

EQUATING

Equating Alternate Forms

The alternate forms of each test in the Cooperative Mathematics series were equated in order to adjust for differences in item difficulty and discrimination. These differences inevitably exist because of the impossibility of obtaining a perfect match between the sets of items which comprise alternate forms.

The data for this equating were obtained from special testing programs conducted in the spring of 1962 and 1963. These programs also provided data for the norms reported in Tables 28-41, and a complete description of the sampling procedures is given in the Norming section of this report.

The first testing program provided data for the equating of the Arithmetic, Algebra I, Algebra II, Geometry, and Trigonometry tests. Random subsamples of schools were selected for this purpose from the national norms samples for 8th-grade Arithmetic, 9th-grade Algebra I, and high school Algebra II, Trigonometry, Geometry Part I, and Geometry Total Score. Because Geometry Part I may be used alone under certain circumstances (see page 7), it was equated separately from Geometry Total Score, although the same sample of students yielded the data for both.

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*Reviewers and advisers are listed in the Acknowledgements section (inside front cover).

**Participants in experimental test administrations are listed in Tables 53-55.

The second testing program provided data for the alternate form equating of the Algebra III, Calculus, Analytic Geometry, and Structure of the Number System tests. Random subsamples of colleges were selected from the national college norms samples to provide equating data for the first three tests. Data to equate the Structure of the Number System test were obtained from a random subsample of students in the 7th- and 8th-grade national norms sample.

In each junior high school, high school, or college which furnished data for the equating of alternate test forms, a single class was randomly selected in each subject matter area offered which corresponded to one of the Cooperative Mathematics tests. Alternate forms of the appropriate test were administered to random halves of these classes, and the School and College Ability Test, Quantitative section (Parts II and IV), was administered to all students in these classes during a second testing session.

The equating procedure, developed by L. R Tucker,[*] permits the calibration of alternate test forms administered to two or more separate groups, all of which have taken a common equating test. This method of calibration involves estimation of the mean and variance of the combined group on each of the forms to be equated. From these estimates, linear conversions to a single raw-score scale were developed.

The Converted Score Scale

The alternate form equating procedure resulted in the establishment of a single raw-score scale for each of the nine Cooperative Mathematics tests. For ease and convenience of interpretation, an arbitrary score scale having a mean of 150 and a standard deviation of 10 was adopted for each test. Table 42 shows the reference groups from which the scaling data were obtained and for which these values hold.

The raw scores on each form of each test were converted to the raw-score scale of one form of that test by the procedures described in the Equating Alternate Forms section of this report. The resulting raw-score distributions were then linearly transformed to converted score distributions.

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[*] For a detailed description of the method, see: Angoff, W.H. Basic equations in scaling and equating. *Statistical Report*, 61-51. Princeton: Educational Testing Service, 1961.
Lord, F. M. Equating test scores—a maximum likelihood solution. *Psychometrika*, 1955, 20 (3), 193-200.

TABLE 42. Converted Score Scale Reference Groups

Test	Reference Group	
	Norms Sample	Grade Level
Arithmetic	National School	8
Structure of the Number System	National School	8
Algebra I	National School	8 and 9 combined
Algebra II	National School	10-12
Geometry, Part I	National School	10-12
Geometry, Total	National School	10-12
Trigonometry	National School	10-12
Algebra III	National College	College
Analytic Geometry	National College	College
Calculus	National College	College

Equating to Earlier Cooperative Mathematics Tests

Tests of the Cooperative Mathematics series were equated to earlier tests wherever test comparability made such a procedure appropriate. The first testing program provided equating data from grade 8 for Arithmetic, grade 9 for Algebra I, and grades 10 through 12 for Algebra II, Geometry, and Trigonometry. These tests were equated to Mathematics for Grades 7, 8, and 9, Elementary Algebra, Intermediate Algebra, Plane Geometry, and Plane Trigonometry, respectively, and the score equivalencies obtained are shown in Table 3.

A random subsample of schools in the national norms sample was selected. Each of these schools administered to one randomly selected class (in addition to the class selected for norming) each earlier Mathematics test for which it offered an appropriate course. A second random subsample was drawn from those schools in the national norms sample which had administered the Cooperative Mathematics tests of the present series. As in the previously described procedure for equating alternate forms, the School and College Ability Test, Quantitative section, was administered to all students in both subsamples during a second testing session. Utilizing these data, the earlier tests were equated by the Tucker method to Form A of the corresponding Cooperative Mathematics test. Since all alternate forms of all tests had previously been equated, a network of conversions was thus established among all possible pairs of earlier and present Mathematics test forms.

NORMING

National and urban norms are provided for Arithmetic in grades 7, 8, and 9, and for Algebra I in grades 8 and 9. Only national norms are provided for Structure of the Number System in grades 7 and 8. National and urban norms for Algebra II, Geometry Part I, Geometry Total Score and Trigonometry and national norms for Algebra III, Analytic Geometry, and Calculus are reported only for combined groups in grade levels ten through twelve, since it is assumed that level of achievement in these subject areas is not related to the grade level at which a student takes the course. National college norms are also provided for Trigonometry, Algebra III, Analytic Geometry, and Calculus, based upon groups combined across all levels at which appropriate courses are offered. These national college norms are also presented for subgroups representing the students' reported major field of study.

The norms samples for the various Cooperative Mathematics Tests were made as comparable as possible by testing in each appropriate Mathematics subject matter area offered by each school in the norms samples. A similar effort was made to achieve comparability among grade norms for the Arithmetic and Algebra I tests. In general, the differences among the numbers of schools or colleges represented in the various norms samples (see Tables 28-41) are due primarily to the variation in course offerings among these institutions. In the following discussion, reference is occasionally made to "the" national or "the" urban norms sample. It should be remembered that there are national samples for each test, urban samples for many of the tests, and in some instances, national and urban samples for grade levels within a particular test.

First Testing Program—National and Urban School Norms Samples

The first testing program provided normative data for the Arithmetic, Algebra I, Algebra II, Geometry, and Trigonometry tests. A random sample of 128 high schools was chosen from lists[*] of public, Roman Catholic, and independent schools, omitting schools which were

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[*] U.S. Department of Health, Education, and Welfare, Office of Education. *Directory of secondary day schools 1958-59*. Washington: U. S. Government Printing Office, 1961.
National Catholic Welfare Conference, Department of Education. *A listing of Catholic secondary schools in U.S.A.* Washington: U. S. Government Printing Office, 1961.
Sargent, F. Porter. *The handbook of private schools.* Boston: Author, 1961.

TABLE 43. School Response in First Norming Program

Test	Grade	Number of Schools Selected	Number of Schools Which Tested	Number of Schools Represented in Norms Sample
Arithmetic	7	224	121	114
Arithmetic	8	224	122	120
Arithmetic	9	224	99	98
Algebra I	8	224	33	32
Algebra I	9	224	130	121
Algebra II	10-12	224	119	114
Geometry	10-12	224	130	129
Trigonometry	10-12	224	79	77

designated as technical, vocational, continuation, or evening high schools. The urban sample was composed of those schools among the 128 which were located in cities having a population of 100,000 or more, augmented by a second sample of 96 schools randomly chosen from cities of that size. The national sample was formed by combining the entire group of 224 urban and non-urban schools, and weighting the data to insure that urban and non-urban students were represented in the proper proportions.

Invitations to participate in the first norming program were sent to the superintendents of the school districts in which the 224 schools are located. For each test normed in this program, Table 43 shows the number of schools which tested and the number from which data suitable for inclusion in the norms distributions were obtained. The failure of all schools tested to be represented in the norms samples is due to the inevitable irregularities in test administration which invalidate the data of a few schools.

Although the national sample was not stratified by geographic region, it is nevertheless informative to see how the sample distribution of students compares by region to the distribution of the national student population. In evaluating this information, shown in Table 44, it should be remembered that the population proportions, by region, of students enrolled in a particular course may in fact differ from the proportions of students in the population as reported in the table.

TABLE 44. Percentages of Students in National School Norms Samples and National Population By Geographic Region*

Test	Grade	Region I**		Region II		Region III		Region IV	
		Sample	Pop.	Sample	Pop.	Sample	Pop.	Sample	Pop.
Arithmetic	7	28	21	33	26	30	38	9	16
Arithmetic	8	28	21	36	27	28	37	8	16
Arithmetic	9	23	22	35	28	34	34	8	15
Algebra I	8	19	21	25	27	49	37	7	16
Algebra I	9	30	22	33	28	29	34	8	15
Algebra II	10-12	31	23	32	29	30	32	7	16
Geometry	10-12	26	23	34	29	31	32	9	16
Trigonometry	10-12	34	23	29	29	28	32	8	16

*Population values compiled from: Schloss, S. & Hobson, Carol J. *Statistics of state school systems: 1957-1958*. Washington: U.S. Government Printing Office, 1961.

**Region I —New England, Middle Atlantic
Region II —East North Central, West North Central
Region III—West South Central, South Atlantic, East South Central
Region IV—Mountain, Pacific

It should be noted that the high school was the primary selection unit for the national and urban school samples, although the Arithmetic and Algebra I tests were administered at the junior high school level. Whenever a selected high school did not include the grade levels appropriate for administering Arithmetic and Algebra I, the high school was requested to submit a list of its feeder junior high schools, from which one school was randomly chosen.

Since type of school support may be related to test score, the national and urban school norms samples were selected in such a manner as to reflect the proportions of public, Roman Catholic, and independent school students in the national population. Due to minor variation among the three types of schools with respect to their eventual participation in the program, it was inevitable that the exact proportions would not be achieved in the final norms groups. Therefore, the data were weighted to insure that each school type was properly represented.

Because a subsample of relatively constant size (one class) was tested in each school, it was necessary to give schools of varying enrollment the proper relative weights in the score distributions on which the various norms tables are based. This was accomplished by selecting public and Roman Catholic schools such that the probability of a school being chosen was proportional to the enrollment in its graduating class. The data were then weighted to equalize the number tested in each school. The independent schools were randomly selected without regard for size, and their data were weighted to reflect school enrollment. In order that the sampling procedure not be biased by the selection of classes within schools, each school was requested to furnish lists of all its classes which qualified for inclusion in each of the reported norms groups. One class was then randomly selected from each list to represent each school in each norms group for which it offered the appropriate course.

Second Testing Program—National School Norms Sample

The second testing program provided normative data for the Algebra III, Calculus, and Analytic Geometry tests at the high school level, and the Structure of the Number System test at the junior high school level. The 1963 national school norms sample consisted of all schools represented in the 1962 national and urban norms samples which again agreed to test and which offered the appropriate courses. Table 45 describes the school response for each test normed at this level in 1963.

For Algebra III, Calculus, and Analytic Geometry, the differences in size of the norms samples between the first and second testing programs were due primarily to the relatively small numbers of schools offering courses in these advanced mathematics subject matter areas. Because of the marked reductions in sample size, it was decided that there were an insufficient number of schools to present both national and urban norms for these tests, and therefore only national norms are provided.

The procedure for selecting classes to represent each school in each norms group differed from that of the first testing program. In the national norms samples of schools that were selected for the second testing program, schools were requested to test in the first class which met on Monday. Integrated course classes (those which draw subject matter content from two or more traditionally organized courses) were eligible for inclusion in the norms samples, provided the appropriate content was covered in the same semester in which the tests were administered.

Weighting procedures to adjust for interschool differences in number of students tested and for deviations from the proper proportions of public, Roman Catholic, and independent schools were identical to those described for the 1962 testing program.

Second Testing Program—National College Norms Sample

The second testing program also provided normative data for the Algebra III, Calculus, Analytic Geometry, and Trigonometry tests at the college level. As in the national school norms sample, these national college norms were made as comparable as possible by testing in each appropriate Mathematics subject matter area offered by each college in the norms samples.

A random sample of 200 was chosen from a list of colleges in the United States* such that the probability of a college being chosen was proportional to its number of entering freshmen. In colleges which included several separate schools (e.g., engineering, liberal arts, etc.), one of these schools was randomly selected and requested to furnish lists of classes in which each test could appropriately be administered. As in the 1963 national school norms sample, integrated course classes were eligible for inclusion provided the appropriate topic was covered in the same semester as the tests were administered. Finally, one class was randomly selected from each list to represent each college in each norms group for which it offered the appropriate course.

Invitations to participate in the testing program were sent to the 200 colleges selected. For each test normed at the college level, Table 46 shows the number of colleges which tested and the number from which data suitable for inclusion in the norms distributions were obtained.

TABLE 45. School Response in Second Norming Program

Test	Grade	Number of Schools Selected Which Offered Course	Number of Schools Which Tested	Number of Schools Represented in Norms Sample
Structure of the Number System	7	76	22	21
Structure of the Number System	8	76	18	17
Algebra III	10-12	60	39	35
Analytic Geometry	10-12	25	23	22
Calculus	10-12	17	11	9

TABLE 46. Response in the National College Sample

Test	Number of Colleges Contacted	Number of Colleges Which Tested	Number of Colleges Represented in Norms Sample
Trigonometry	200	64	60
Algebra III	200	56	49
Analytic Geometry	200	54	49
Calculus	200	73	64

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*U.S. Department of Health, Education, and Welfare, Office of Education. *Opening (Fall) enrollment in higher education, 1960*. Washington: U.S. Government Printing Office, 1960.

TABLE 47. Percentages of Students in National College Norms Samples and National Population By Geographic Region*

Test	Region I**		Region II		Region III		Region IV	
	Sample	Pop.	Sample	Pop.	Sample	Pop.	Sample	Pop.
Trigonometry	6	21	28	29	39	27	27	23
Algebra III	5	21	31	29	36	27	27	23
Analytic Geometry	11	21	30	29	36	27	23	23
Calculus	12	21	31	29	28	27	30	23

*Population values compiled from: U. S. Department of Health, Education, and Welfare, Office of Education. *Opening (Fall) enrollment in higher education, 1960*. Washington: U.S. Government Printing Office, 1960.

**Region I —New England, Middle Atlantic
Region II —East North Central, West North Central
Region III—West South Central, South Atlantic, East South Central
Region IV—Mountain, Pacific

A comparison of the norms sample and population distributions of college freshmen by geographic region is shown in Table 47. As in the interpretation of Table 44, it should be remembered that the population proportions, by region, of students enrolled in a particular course may in fact differ from the proportions of students in the population as reported in the table.

Each examinee was requested to categorize his major field of study as Education, Engineering, Liberal Arts, or Other. Norms are presented for the first three of these subgroups and for the total group combined across major fields. Because of the great variability among colleges with respect to the proportions of students in the various major fields, the college data were not weighted to equalize the number of students tested in each subject matter area in each college.

School and College Ability Test Summary Statistics

The Quantitative section (Parts II and IV) of the School and College Ability Test (SCAT) was administered to each student in the first and second testing programs. The SCAT Quantitative mean and standard deviation for each norms distribution are given (see Tables 28-41) as an aid to an understanding of the nature of the sample from which the normative data were obtained. Local groups for which SCAT Quantitative scores are available may be compared to the norms sample in terms of quantitative ability. Thus, test users may more meaningfully interpret any given norms table.

Precision of the Norms

The sampling error of the norms for Cooperative Mathematics Tests is determined chiefly by the number of schools comprised by the norms samples, since the school was the primary sampling unit. In planning the norms program, the attempt was made to select school or college samples of a size such that further increases would produce only negligible improvement in score interpretation. However, the accuracy with which a percentile rank is determined for an individual is also a function of the standard error of measurement of the test. If the standard error due to sampling is reduced to approximately one-half the standard error of measurement, the combined error effect will not be appreciably larger than that due to measurement alone, and the sampling error thus becomes negligible.

By estimating from other available data the proportion of the total test variance attributable to variation among schools, it was possible to compute reasonable upper limits for the standard errors of the norms sample means and medians. For all the norms samples of all the Cooperative Mathematics Tests, with the exception of the Calculus national school sample, it was determined that the estimated maximum standard error of the median was less than one-half the corresponding standard error of measurement. Thus it can be seen that sampling error contributes only a negligible amount to the total error of score interpretation. In the case of the Calculus sample, sampling error was found to increase the total standard error by a maximum of slightly less than one converted score point.

The norms for the Arithmetic, Algebra I, and Structure of the Number System tests are presented by grade, and such a procedure is meaningful only if statistical significance between pairs of successive grade means can be shown. Because many of the same schools are represented in two or more grade norms samples, the sampling errors are correlated to some extent. For this reason, the procedure of adding variance errors and taking the square root overestimates the true standard error of the difference between grade means. An examination of all pairs of successive grade means in both the national and urban school samples reveals the inter-grade differences to be at least twice the maximum possible standard error of the difference in each case, with the exception of the Algebra I urban school sample. Thus the differences seem, in general, to justify the presentation of separate grade norms. The difference between the Algebra I grade 8 and 9 means is greater than one standard error of the difference, and may be considered a population difference with only a moderate level of confidence.

It is interesting to note that while the differences between the Arithmetic means for grades 7 and 8, and grades 8 and 9, are highly significant, the means for grades 7 and 9 are considerably lower than the 8th-grade mean. This similarity between the 7th- and 9th-grade Arithmetic norms samples probably is due to the presence of relatively large numbers of less able individuals in 9th-grade Arithmetic classes.

Suburban Case Study

The group of suburban schools for which score distributions are provided (see Tables 5-8) should not be considered representative of the national population of suburban schools, because it was not randomly selected. Instead, a purposive sample was chosen which was judged to comprise schools having a preponderance of high-ability students. The Cooperative Mathematics Tests were administered to all classes in each appropriate Mathematics subject matter area offered by each school, and all classes took the Quantitative section of SCAT during a second testing session. The SCAT Quantitative mean scores for these suburban samples are consistently higher than the corresponding means for the national and urban school norms samples, thus lending empirical support to the original judgment concerning the caliber of these students.

STATISTICAL CHARACTERISTICS

Validity

The Cooperative Mathematics Tests are measures of developed abilities, and thus their content validity is of primary importance. Content validity is best insured by entrusting test construction to persons well-qualified to judge the relationship of test content to teaching objectives. The details of these test construction procedures are described in the Development section of this report. Nevertheless, it is recommended that each test user make an individual judgment of content validity with respect to his own course content and educational aims.

Reliability

The reliabilities reported for the Cooperative Mathematics Tests are measures of internal consistency, computed using the Kuder-Richardson Formula 20. These reliabilities and their associated standard errors of measurement were obtained from subsamples selected randomly from the norms groups as shown in Table 48.

Of the thirty-three reliabilities shown in Table 48, four are .90 or higher, fourteen are in the range .85 through .89, twelve are in the range .80 through .84, and three are in the range .77 through .79. Relatively small standard deviations are associated with the three lowest reliabilities.

The reliabilities reported in this table were computed for groups selected from many schools and as such are overestimates of the reliability to be obtained for a more homogeneous group within a single school. Therefore, test users should compute reliabilities for their own groups.

TABLE 48. Statistical Characteristics

Test	Form	No. of Items	Sample of Examinees				Reliability	S.E. Meas.		Corr. with SCAT-Q
			Grade	N	Mean*	S.D.*		Raw	Conv.	
Arithmetic	A	50	7	300	25.56	7.95	.86	2.99	3.36	.77
	B	50	7	300	23.99	8.99	.89	2.97	3.02	.80
	C	50	7	300	22.93	9.94	.91	2.99	3.15	.79
	A	50	8	300	28.18	9.07	.89	2.97	3.34	.70
	B	50	8	300	28.82	9.65	.91	2.90	2.95	.79
	C	50	8	300	26.91	9.53	.90	3.03	3.19	.73
	A	50	9	300	22.87	7.96	.86	3.03	3.40	.74
	B	50	9	300	24.14	8.67	.88	3.00	3.05	.70
	C	50	9	300	22.60	8.23	.86	3.08	3.25	.77
Structure of the Number System	A	40	7	285	15.59	6.32	.82	2.70	3.87	.64
	B	40	7	285	17.25	6.42	.82	2.69	3.79	.61
	A	40	8	255	18.62	7.19	.86	2.73	3.92	.78
	B	40	8	245	20.73	6.94	.84	2.75	3.87	.74
Algebra I	A	40	8	300	24.07	7.12	.86	2.64	3.68	.54
	B	40	8	300	23.05	6.62	.84	2.69	3.70	.55
	A	40	9	300	22.30	6.82	.85	2.67	3.72	.77
	B	40	9	300	22.01	6.87	.85	2.70	3.72	.75
Algebra II	A	40	10-12	300	20.94	7.01	.84	2.76	3.79	.62
	B	40	10-12	300	19.87	8.03	.89	2.65	3.54	.73
Geometry, Part I	A	40	10-12	300	25.38	5.56	.80	2.46	4.13	.74
Total	A	80	10-12	300	40.35	10.22	.87	3.68	3.63	.73
Part I	B	40	10-12	300	23.55	7.17	.87	2.62	3.70	.72
Total	B	80	10-12	300	40.83	12.03	.90	3.80	3.20	.72
Trigonometry	A	40	10-12	300	15.73	6.06	.80	2.73	4.50	.50
	B	40	10-12	300	16.25	6.60	.83	2.75	4.06	.55
	A	40	College	445	14.81	5.68	.78	2.66	4.38	.44
	B	40	College	450	14.92	5.99	.80	2.71	4.00	.49
Algebra III	A	40	College	450	16.87	6.62	.84	2.66	4.11	.58
	B	40	College	450	18.40	5.97	.80	2.64	4.34	.60
Analytic Geometry	A	35	College	450	17.10	5.38	.79	2.47	4.63	.47
	B	35	College	450	17.46	5.23	.77	2.49	4.90	.52
Calculus	A	60	College	450	28.39	9.11	.87	3.28	3.42	.40
	B	60	College	350	27.39**	8.37**	.84**	3.31**	4.06**	.39**

*In raw score units

**Estimated from scores on 59 items only, because the form administered contained 1 defective item. This item has been replaced in the final published form.

Correlation with SCAT Quantitative

Table 48 also gives the correlation of each form of each Mathematics test (by grade where appropriate) with the Quantitative score on the School and College Ability Test. The differences between the various reliabilities and correlations are indices of the degree to which the Mathematics tests measure abilities not tapped by the SCAT Quantitative scores. The correlations in each case are exceeded by the Mathematics test reliabilities, the differences in general being greatest for the higher level tests (Geometry, Trigonometry, Algebra III, Calculus, and Algebra II). Since SCAT Quantitative emphasizes computational skills, this trend in the data is consistent with the decreased emphasis on elementary mathematical operations one might expect to find in the more advanced mathematics courses.

Item Discrimination

An important characteristic of a test is its effectiveness in discriminating between high and low ability individuals. The distribution of biserial correlations between each item and total test score provides a measure of this ability to discriminate. For each Cooperative Mathematics test, Table 49 shows the mean and standard deviation of this distribution, obtained from the samples described in Table 48.

An examination of Table 49 reveals the mean biserial correlations to be at a rather uniformly high level for all the Cooperative Mathematics Tests, thus indicating good discriminating power for all tests in the series.

TABLE 49. Item Discrimination Characteristics

Test	Form	Grade	Item—Total Score Biserial Correlations	
			Mean	S.D.
Arithmetic	A	7	.45	.15
	B	7	.48	.15
	C	7	.52	.14
	A	8	.51	.13
	B	8	.55	.12
	C	8	.51	.14
	A	9	.41	.15
	B	9	.45	.16
	C	9	.43	.14
Structure of the Number System	A	7	.43	.15
	B	7	.46	.11
	A	8	.50	.12
	B	8	.48	.12
Algebra I	A	8	.52	.13
	B	8	.48	.15
	A	9	.50	.14
	B	9	.48	.14
Algebra II	A	10-12	.46	.16
	B	10-12	.54	.12
Geometry, Part I	A	10-12	.45	.14
Total	A	10-12	.41	.14
Part I	B	10-12	.50	.11
Total	B	10-12	.43	.14
Trigonometry	A	10-12	.42	.13
	B	10-12	.45	.12
	A	College	.39	.12
	B	College	.42	.12
Algebra III	A	College	.46	.09
	B	College	.43	.13
Analytic Geometry	A	College	.45	.11
	B	College	.44	.10
Calculus	A	College	.44	.12
	B	College	.41	.12

Speededness

In order to gain a more precise understanding of exactly what is being measured by a test, it is necessary to assess the relative influences of speed and power on the test scores. The samples described in Table 48 also provided the data required to analyze item responses for each Cooperative Mathematics test. Table 50 shows, for each of these samples, the percentage of students who answered the last item in the test, and the percentage of students who reached a point three-quarters of the way through the test.

Examination of Table 50 reveals that Algebra I is the only test of the series for which speededness can be regarded as relatively unimportant; all other tests exhibiting speededness characteristics to some degree. Because the tests in this series have also proved somewhat difficult, it is not possible with the available data to isolate the uncontaminated effect of speededness.

TABLE 50. Percentages of Students Answering the Last Item and Reaching the Three-Quarter Point in Each Test

Test	Form	Grade	% Answering Last Item	% Reaching Three-Quarter Point
Arithmetic	A	7	62.3	92.3
	B	7	56.0	87.3
	C	7	68.3	90.3
	A	8	66.3	93.7
	B	8	68.0	93.7
	C	8	76.7	94.7
	A	9	68.0	91.0
	B	9	64.7	91.0
	C	9	75.0	93.7
Structure of the Number System	A	7	60.4	90.9
	B	7	66.0	93.3
	A	8	72.5	96.1
	B	8	77.1	98.0
Algebra I	A	8	91.0	100.0
	B	8	87.3	100.0
	A	9	90.3	99.3
	B	9	82.3	97.7
Algebra II	A	10-12	71.3	95.7
	B	10-12	69.7	96.3
Geometry, Part I	A	10-12	80.0	99.0
Part II	A	10-12	48.3	91.7
Part I	B	10-12	77.3	98.3
Part II	B	10-12	61.3	94.3
Trigonometry	A	10-12	49.0	84.3
	B	10-12	47.0	88.0
	A	College	33.5	71.2
	B	College	36.9	73.3
Algebra III	A	College	48.9	85.1
	B	College	51.1	88.4
Analytic Geometry	A	College	60.2	89.6
	B	College	52.0	89.3
Calculus, Part I	A	College	61.6	95.1
Part II	A	College	61.8	94.9
Part I	B	College	53.3	92.9
Part II	B	College	48.4	88.2

Difficulty

The raw-score mean for each norms group provides evidence of test difficulty. Middle difficulty for a test consisting of five-choice items corresponds to a mean equal to 60 per cent of the number of items. However, to the extent that the tests are speeded, the 60 per cent level is too demanding a criterion by which to judge test difficulty. Table 51 shows the raw-score means expressed as percentages of items in the tests. These data were obtained from the samples described in Table 48.

A comparison of these results with the speededness indices given in Table 50 re-emphasizes the strong relationship, mentioned previously, between test difficulty and speededness.

TABLE 51. Raw Score Means Expressed as Percentages of Number of Items

Test	Form	Grade	Percentage of Items
Arithmetic	A	7	51
	B	7	48
	C	7	46
	A	8	36
	B	8	38
	C	8	34
	A	9	46
	B	9	48
	C	9	43
Structure of the Number System	A	7	39
	B	7	43
	A	8	47
	B	8	32
Algebra I	A	8	60
	B	8	58
	A	9	56
	B	9	55
Algebra II	A	10-12	52
	B	10-12	50
Geometry, Part I	A	10-12	63
Total	A	10-12	50
Part I	B	10-12	59
Total	B	10-12	51
Trigonometry	A	10-12	39
	B	10-12	41
	A	College	37
	B	College	37
Algebra III	A	College	42
	B	College	46
Analytic Geometry	A	College	49
	B	College	50
Calculus	A	College	47
	B	College	46

Equivalence of Alternate Forms

The initial steps to insure the equivalence of alternate forms were embodied in the test development procedures. The extent to which parallel content of alternate forms was achieved may be assessed by an examination of the various item content classifications shown in Tables 9-27. Because the alternate forms of each test have been equated to a common score scale, a comparison of the relationships between raw and scaled scores for each form can give additional indications of the relative difficulty of alternate forms. If two forms of a test are similar in difficulty, a given raw score should be equivalent to approximately the same converted score on both forms. Table 52 gives converted score equivalents of selected raw scores for each form of each Cooperative Mathematics test.

The data in Table 52 indicate that alternate forms of the same test are, in general, similar in difficulty. The largest difference found is that between forms of Geometry, Part I at the lower end of the scale.

TABLE 52. Converted Score Equivalents of Selected Raw Scores

Test	Raw Score	Converted Score		
		Form A	Form B	Form C
Arithmetic	15	136	137	138
	30	153	152	154
	45	170	167	170
Structure of the Number System	10	137	135	
	20	151	149	
	30	165	163	
Algebra I	10	134	136	
	20	148	149	
	30	162	163	
Algebra II	10	135	137	
	20	149	150	
	30	163	163	
Geometry, Part I	10	125	132	
	20	142	146	
	30	158	160	
Total	20	130	134	
	40	150	150	
	60	170	167	
Trigonometry	10	142	142	
	20	159	157	
	30	175	171	
Algebra III	10	140	136	
	20	155	152	
	30	170	169	
Analytic Geometry	10	136	136	
	20	155	155	
	30	175	174	
Calculus	15	136	135	
	30	152	153	
	45	167	171	

TABLE 53. Mathematics Pretest—Schools Which Administered One or More of the Tests

Alabama

Susan Moore High School, Blountsville
Enterprise Junior High School, Enterprise
Thomas W. Martin High School, Gorgas
Choctaw County Training School, Lisman

Arizona

Arizona High School, Seligman

Arkansas

Altheimer High School, Altheimer
Egypt High School, Walnut Ridge

California

Fort Bragg Junior High School, Fort Bragg
Fort Bragg Senior High School, Fort Bragg
Jordan Junior High School, Palo Alto
Palo Alto Senior High School, Palo Alto
Marshall Junior High School, Pasadena
McKinley Junior High School, Pasadena
Washington Junior High School, Pasadena
Sonora Union High School, Sonora

Colorado

Baseline Junior High School, Boulder
Hill Junior High School, Denver
Hillrose School, Hillrose
Hotchkiss High School, Hotchkiss

Connecticut

Darien High School, Darien
Mather Junior High School, Darien
Middlesex Junior High School, Darien
Weston Junior High School, Weston
Bedford Junior High School, Westport
Long Lots Junior High School, Westport

Delaware

Alexis I. DuPont High School, Wilmington
Mount Pleasant Junior High School, Wilmington

Florida

Frostproof High School, Frostproof
Robert E. Lee High School, Jacksonville

Georgia

Arkwright Elementary School, Atlanta
Beecher Hills Elementary School, Atlanta
Cascade Elementary School, Atlanta
Margaret Fain Elementary School, Atlanta
Southwest High School, Atlanta
West Manor Elementary School, Atlanta
Griffin High School, Griffin
Harris County High School, Hamilton
Dickerson Elementary School, Vidalia
Dickerson Training School, Vidalia
Pike County High School, Zebulon

Idaho

Payette High School, Payette

Illinois

Kankakee High School, Kankakee
Central Junior High School, LaGrange
Cossitt School, LaGrange
Marseilles Junior-Senior High School, Marseilles
Mattoon High School, Mattoon
Morris High School, Morris
Alwood High School, Woodhull

Indiana

Economy School, Economy
Centennial Junior High School, Evansville
Francis J. Reitz High School, Evansville

Indiana (Continued)

Frankton High School, Frankton
Emerson High School, Gary
Knightstown High School, Knightstown
Scottsburg High School, Scottsburg
Scottsburg Junior High School, Scottsburg
Wakarusa Community School, Wakarusa

Iowa

Bedford Community High School, Bedford
Wilson Junior High School, Cedar Rapids
Sioux Valley High School, Lake Park
Ventura Community School, Ventura

Kansas

Berryton High School, Berryton
Burlington High School, Burlington
Fowler Public School, Fowler
LeRoy Grade School, LeRoy
LeRoy Rural High School, LeRoy

Kentucky

Ballard Memorial High School, Barlow
Barlow Elementary School, Barlow
Bloomfield Elementary School, Bloomfield
Bloomfield High School, Bloomfield
Howevalley High School, Cecilia
Central City High School, Central City
Frederick Fraize School, Cloverport

Louisiana

Westdale Junior High School, Baton Rouge
Converse High School, Converse
Goldonna High School, Goldonna
Starks High School, Starks

Maine

Williams High School, Oakland

Maryland

Bruce High School, Westernport

Massachusetts

Andover Junior High School, Andover
Brookline High School, Brookline
Devotion Junior High School, Brookline
Driscoll Junior High School, Brookline
Heath Junior High School, Brookline
Lawrence Junior High School, Brookline
Lincoln Junior High School, Brookline
Pierce Junior High School, Brookline
Runkle Junior High School, Brookline
Baker Junior High School, Chestnut Hill
Millis Junior-Senior High School, Millis
Newton Junior High School, Newtonville
Newton Senior High School, Newtonville
Peabody High School, Peabody
Mount Everett Regional School, Sheffield

Michigan

Carsonville High School, Carsonville
Central High School, Grand Rapids
Grosse Pointe Senior High School, Grosse Pointe
Romeo Community High School, Romeo
Romeo Junior High School, Romeo
Saugatuck High School, Saugatuck

Minnesota

Chaska Public Junior-Senior High School, Chaska
Oklee High School, Oklee
Westwood Junior High School, St. Louis Park
Williams High School, Williams

Mississippi

Clay County Vocational High School, Montpelier
Oakland Consolidated High School, Oakland

TABLE 53 *(Continued)*. Pretest—Schools Which Administered One or More of the Tests

Missouri

Green Ridge School, Green Ridge
Northeast Junior High School, Kansas City
Northeast Senior High School, Kansas City
New Madrid High School, New Madrid

Montana

Dixon High School, Dixon
Custer County High School, Miles City
Washington Elementary School, Miles City
Opheim High School, Opheim

Nebraska

Plymouth High School, Plymouth
Walthill Public School, Walthill

New Hampshire

Plymouth High School, Plymouth
Thayer High School, Winchester

New Jersey

Battin High School, Elizabeth
Hamilton Junior High School, Elizabeth
Jefferson High School, Elizabeth
Valley Road School, Princeton
Witherspoon School, Princeton
Bridgewater-Raritan High School, Raritan
South Orange Junior High School, South Orange

New York

Metropolitan Vocational High School, New York
Oneida High School, Oneida
Patchogue Junior High School, Patchogue
Patchogue Senior High School, Patchogue
Saint Johnsville Central School, Saint Johnsville
Sherman Central School, Sherman
Spencerport Central School, Spencerport

North Carolina

E. M. Holt School, Burlington
Pine Forest High School, Fayetteville
Ridgeview School, Hickory
Nebo High School, Nebo

North Dakota

Dodge Public School, Dodge
Drake Public School, Drake

Ohio

Coventry High School, Akron
Celina High School, Celina
Jackson Center School, Jackson Center
Western Township High School, Latham
Swanton Local School, Swanton
Swanton Village Elementary School, Swanton

Oklahoma

Alexander Bell Junior High School, Tulsa
Central High School, Tulsa
Waynoka High School, Waynoka

Oregon

Union High School, Crane
Gregory Heights Elementary School, Portland
Madison High School, Portland

Pennsylvania

East Berlin High School, East Berlin
Montrose High School, Montrose
Andrew W. Mellon Junior High School, Mount Lebanon

Pennsylvania (Continued)

Jefferson Junior High School, Mount Lebanon
Mount Lebanon High School, Mount Lebanon
East Lebanon County Joint High School, Newmanstown
Oley Valley Area High School, Oley
Abraham Lincoln High School, Philadelphia
Olney High School, Philadelphia
Mount Lebanon Senior High School, Pittsburgh
Washington Street Junior High School, Royersford
Salisbury-Elk Lick Joint High School, Salisbury
Swarthmore Junior-Senior High School, Swarthmore

South Carolina

Ebenezer High School, Dalzell

South Dakota

Dell Rapids Public School, Dell Rapids

Tennessee

Central High School, Chattanooga
Lawrence County High School, Lawrenceburg

Texas

Big Sandy High School, Big Sandy
Del Rio High School, Del Rio
Edinburg High School, Edinburg
Edinburg Junior High School, Edinburg
Henry High School, Elkhart
Lefors High School, Lefors
Lefors Junior High School, Lefors
Joe F. Saegert Junior High School, Seguin
Seguin High School, Seguin

Utah

American Fork Junior High School, American Fork
Payson High School, Payson
Payson Junior High School, Payson

Vermont

Brattleboro Union High School, Brattleboro

Virginia

Mary Nottingham Smith High School, Accomac
Patrick Henry School, Ashland
Charles City High School, Charles City
Falls Church High School, Falls Church
Whittier Intermediate School, Falls Church
Gloucester High School, Gloucester

Washington

Granger High School, Granger
Kennewick Senior High School, Kennewick
Denny Junior High School, Seattle
Eckstein Junior High School, Seattle

West Virginia

Buckhannon-Upshur Junior High School, Buckhannon
Buckhannon-Upshur Senior High School, Buckhannon
Fayetteville High School, Fayetteville

Wisconsin

Almond High School, Almond
Altoona Public School, Altoona

Wyoming

Dubois High School, Dubois
Rawlins Junior High School, Rawlins
Rawlins Senior High School, Rawlins

TABLE 54. Mathematics Pretest—Colleges Which Administered One or More Tests

Alabama
Auburn University, Auburn

California
San Jose State College, San Jose

Colorado
University of Colorado, Boulder

District of Columbia
The George Washington University

Florida
University of Miami, Coral Gables

Idaho
University of Idaho, Moscow

Illinois
Northwestern University, Evanston
University of Illinois, Urbana

Indiana
Indiana University, Bloomington
Hanover College, Hanover

Kansas
The University of Kansas, Lawrence

Kentucky
Villa Madonna College, Covington

Louisiana
The University of Southwestern Louisiana, Lafayette
Tulane University of Louisiana, New Orleans
Xavier University, New Orleans

Maine
University of Maine, Orono

Massachusetts
University of Massachusetts, Amherst
American International College, Springfield

Michigan
Siena Heights College, Adrian
University of Detroit, Detroit

Minnesota
Bemidji State College, Bemidji

Mississippi
Mississippi State University, State College

Missouri
University of Missouri, Columbia

Nevada
University of Nevada, Reno

New Jersey
Newark College of Engineering, Newark
Rutgers, The State University, New Brunswick
Princeton University, Princeton

New Mexico
University of New Mexico, Albuquerque

New York
Brooklyn College, Brooklyn
City College, New York
Rensselaer Polytechnic Institute, Troy

Oklahoma
University of Tulsa, Tulsa

Pennsylvania
Lebanon Valley College, Annville
The Pennsylvania State University, University Park

South Carolina
University of South Carolina, Columbia

Tennessee
Vanderbilt University, Nashville

Texas
Texas Christian University, Fort Worth
Incarnate Word College, San Antonio

Utah
University of Utah, Salt Lake City

Vermont
Middlebury College, Middlebury

Washington
Seattle Pacific College, Seattle
University of Washington, Seattle

West Virginia
Salem College, Salem

TABLE 55. Schools Included in the National Norms

School	Arithmetic			No. System		Alg. I		Alg. II	Geom.	Trig.	Alg. III	Analyt. Geom.	Calc.
	7	8	9	7	8	8	9						
Alabama													
A. H. Parker High School, Birmingham*			★				★		★	★			
John Carroll High School, Birmingham*			★				★	★	★		★		
Phillips High School, Birmingham*							★	★	★	★			
Saint Francis Xavier, Birmingham*	★	★											
Arizona													
Catalina High School, Tucson*							★		★	★	★		
Townsend Junior High School, Tucson*	★	★											
California													
Heinz Kaiser School, Costa Mesa	★	★											
La Loma Junior High School, Modesto	★	★		★	★								
Thomas Downey High School, Modesto			★				★	★	★				
Newport Harbor High School, Newport Beach			★				★	★	★		★		
Sequoia High School, Redwood City			★				★		★	★			
Samuel Gompers Junior High School, San Diego*	★		★	★	★		★						
Lincoln Senior High School, San Diego*								★	★				
District of Columbia													
Anacostia High School*								★	★		★		
Kramer Junior High School*	★	★	★	★	★	★	★						
Florida													
Clearwater High School, Clearwater								★	★	★	★		★
Clearwater Junior High School, Clearwater	★	★	★	★		★	★						
McNicol Junior High School, Hollywood		★	★	★									
South Broward High School, Hollywood								★	★	★			
Arlington Junior High School No. 213, Jacksonville*	★	★				★							
Terry Parker Senior High School, Jacksonville*			★				★	★	★	★			
Southwest Miami High School, Miami*								★	★	★	★	★	
North Miami Junior High School, North Miami*	★	★	★	★	★		★						
North Miami Senior High School, North Miami*								★	★	★	★	★	
South Miami Junior High School, South Miami*	★	★	★	★		★	★						
St. Petersburg Senior High School, St. Petersburg*								★	★		★	★	
South Side Junior High School, St. Petersburg*	★	★	★	★		★	★						
Georgia													
Margaret Mitchell School, Atlanta*	★												
Northside High School, Atlanta*		★	★				★	★	★				
West Fulton High School, Atlanta*		★					★	★	★	★		★	
William A. Bass High School, Atlanta*		★					★	★	★	★			
Idaho													
Mackay High School, Mackay	★	★					★	★	★				
Illinois													
Fenger High School, Chicago*							★	★	★	★			
Graeme Stewart Elementary School, Chicago*	★	★											
Hyde Park High School, Chicago*							★		★	★			★
Kenwood Elementary School, Chicago*	★	★											
Lindblom Technical High School, Chicago*							★		★	★	★		
Mount Carmel High School, Chicago*			★					★	★	★	★	★	
Mount Vernon Elementary School, Chicago*	★	★											
Senn High School, Chicago*							★	★	★	★			
William G. Beale Upper Grade Center, Chicago*	★	★											
Notre Dame High School, Quincy							★	★	★				
Quincy Junior High School, Quincy	★	★	★			★							
Quincy Senior High School, Quincy								★	★	★			
Saint Boniface Elementary School, Quincy	★	★											
Robinson High School, Robinson	★	★					★	★	★				
Teutopolis Community High School, Teutopolis							★	★	★				
Teutopolis Elementary School, Teutopolis	★	★											
Indiana													
Columbus Senior High School, Columbus								★	★	★			
Northside Junior High School, Columbus	★	★	★				★						
Benjamin Bosse High School, Evansville*			★				★	★	★		★	★	
Howard Roosa Junior High School, Evansville*	★	★											
Donald E. Gavit Junior-Senior High School, Hammond*	★	★	★										
Hammond High School, Hammond*							★	★	★		★	★	

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*Denotes schools in the Urban Norms where provided.

TABLE 55 *(Continued)*. Schools Included in the National Norms

School	Arithmetic			No. System		Alg. I		Alg. II	Geom.	Trig.	Alg. III	Analyt. Geom.	Calc.
	7	8	9	7	8	8	9						
Indiana (Continued)													
Crispus Attucks High School, Indianapolis*			*				*	*	*	*			
John Adams High School, South Bend*			*				*		*		*	*	*
John F. Nuner Junior High School, South Bend*		*				*							
Spiceland High School, Spiceland	*	*	*				*	*	*	*			
Iowa													
Maquoketa Community High School, Maquoketa			*				*	*	*				
Maquoketa Junior High School, Maquoketa	*	*											
De Sales Central High School, Ossian			*				*	*	*				
De Sales School, Ossian	*	*											
Kansas													
Maur Hill School, Atchison			*				*	*	*	*	*	*	
Horace Mann Junior High School, Wichita*	*	*	*				*						
North High School, Wichita*								*	*		*		
Kentucky													
Clifty High School, Clifty							*	*					
Louisiana													
Cor Jesu High School, New Orleans*							*	*	*				
Saint Raphael School, New Orleans*	*	*				*							
Rayne High School, Rayne	*	*						*	*				
Maine													
Bath Junior High School, Bath	*	*	*			*	*						
Morse High School, Bath								*	*				
Maryland													
Eastern High School, Baltimore*								*	*	*			
Woodbourne Junior High School, Baltimore*	*	*	*				*						
Massachusetts													
Middlesex School, Concord						*		*	*	*			
Saint Patrick Elementary and High School, Lawrence	*	*					*		*				
Plymouth High School, Plymouth								*	*	*	*		
Plymouth Junior High School, Plymouth	*	*	*				*						
Chapel Hill School, Waltham		*		*					*				
Catholic Memorial High School, West Roxbury*							*	*	*	*			
Michigan													
Bangor Public School No. 14, Bangor	*	*					*	*	*				
Dansville Agricultural School, Dansville	*	*	*				*		*	*			
Foch Junior High School, Detroit*	*	*	*										
McMichael Junior High School, Detroit*	*	*		*	*								
Northwestern High School, Detroit*			*				*	*	*				
Saint Anthony High School, Detroit*			*				*	*	*	*		*	
Saint Leo High School, Detroit*			*				*		*	*			
Saint Raymond Convent, Detroit*	*	*											
Southeastern High School, Detroit*							*	*	*				
Farmington High School, Farmington								*	*	*			
Farmington Junior High School, Farmington	*	*	*			*	*						
Godwin Heights High School, Grand Rapids*	*	*					*	*	*	*			
McDevitt School, Jackson	*												
Vandercook Lake High School, Jackson		*				*	*		*	*			
Graveraet High School, Marquette			*				*	*	*			*	
Saint Michael's School, Marquette	*	*											
Sacred Heart Academy, Mount Pleasant		*	*				*	*		*			
Minnesota													
Sebeka High School, Sebeka	*	*	*	*	*		*	*	*	*			
Missouri													
Clayton High School, Clayton											*		*
Central Junior High School, Kansas City*	*	*		*	*	*							
Central Senior High School, Kansas City*			*				*		*				
Poplar Bluff Senior High School, Poplar Bluff	*	*	*				*	*	*				
Beaumont High School, St. Louis*			*				*		*				

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*Denotes schools in the Urban Norms where provided.

TABLE 55 *(Continued)*. Schools Included in the National Norms

School	Arithmetic			No. System		Alg. I		Alg. II	Geom.	Trig.	Alg. III	Analyt. Geom.	Calc.
	7	8	9	7	8	8	9						
Nebraska													
Saint Patrick's Academy, Sidney	★	★					★	★	★				
New Jersey													
Lincoln High School, Jersey City*			★				★	★	★	★			
Public School No. 12, Jersey City*	★	★											
Newton Elementary School, Newton	★	★											
Newton High School, Newton			★				★	★	★		★		
Red Bank Catholic High School, Red Bank							★	★	★	★	★		
Saint James Grammar School, Red Bank	★	★											
Albert E. Grice Junior High School, Trenton*	★	★	★	★	★		★						
Hamilton High School—West, Trenton*								★	★	★			
Notre Dame High School, Trenton*							★	★	★				
Saint Raphael School, Trenton*	★	★											
New Mexico													
Las Vegas Junior High School, Las Vegas				★	★								
Robertson High School, Las Vegas	★	★				★	★	★	★			★	
Wagon Mound Elementary School, Wagon Mound	★	★											
Wagon Mound High School, Wagon Mound			★						★				
New York													
Albany Academy for Girls, Albany*	★	★				★	★	★	★	★	★		
Arthur S. Somers Junior High School 252, Brooklyn*	★	★	★										
John Wilson Junior High School 211, Brooklyn*	★	★	★										
Samuel J. Tilden High School, Brooklyn*							★	★					
Thomas Jefferson High School, Brooklyn*								★	★	★			
The Park School of Buffalo, Buffalo*	★	★			★		★		★		★		★
West Seneca Central Junior High School, Buffalo*	★	★	★				★						
West Seneca Central School, Buffalo*								★	★	★	★		
Alva T. Stanforth Junior High School, Elmont, Long Island*	★	★	★				★						
Elmont Memorial High School, Elmont, Long Island					★								
Forest Hills High School, Forest Hills*			★				★	★	★	★			
Junior High School 204, Long Island City*	★	★			★								
William Cullen Bryant High School, Long Island City*							★	★	★	★			
Lowville Academy and Central School, Lowville	★	★	★				★	★	★	★			
Junior High School 104, New York*	★	★		★									
Mount Saint Michael Grammar School, New York*	★	★											
Mount Saint Michael Academy, New York*							★	★	★		★	★	
Saint Helena's High School, New York*							★		★				
Our Lady of Lourdes High School, Poughkeepsie											★	★	
Saint Mary's School, Poughkeepsie		★											
Schalmont High School, Schenectady	★	★	★				★	★					
North Carolina													
Eastway Junior High School, Charlotte*	★	★	★			★	★						
Garinger High School, Charlotte*								★	★	★			
Ranger Elementary School, Culberson	★	★											
Davis High School, Engelhard	★	★	★					★	★				
Greensboro Senior High School, Greensboro*								★	★	★	★	★	
Kiser Junior High School, Greensboro*	★	★	★				★						
Murphy High School, Murphy			★				★	★	★	★	★		
North Dakota													
Pembina Public School, Pembina	★	★	★					★	★				
Ohio													
Amelia High School, Amelia								★	★	★			
Amelia Junior High School, Amelia		★	★				★						
Elder High School, Cincinnati*			★				★	★	★	★	★		★
Orrville High School, Orrville			★				★	★	★	★			
Orrville Junior High School, Orrville	★	★											
Boardman High School, Youngstown*			★				★	★	★			★	
Boardman Junior High School, Youngstown*	★	★											
Grover Cleveland Junior High School, Zanesville	★	★	★				★						
Zanesville High School, Zanesville								★	★	★			
Oklahoma													
Healdton Junior-Senior High School, Healdton	★	★	★					★	★				
Central High School, Tulsa*								★	★	★	★		
Edison Junior-Senior High School, Tulsa*											★		★
Madison Junior High School, Tulsa*	★	★	★	★	★		★						

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*Denotes schools in the Urban Norms where provided.

TABLE 55 *(Continued)*. Schools Included in the National Norms

School	Arithmetic			No. System		Alg. I		Alg. II	Geom.	Trig.	Alg. III	Analyt. Geom.	Calc.
	7	8	9	7	8	8	9						
Oregon													
McMinnville High School, McMinnville	★	★	★			★	★	★	★	★	★	★	
Beaumont School, Portland*	★	★				★							
U. S. Grant High School, Portland*			★				★	★	★	★			
Pennsylvania													
Bellwood-Antis Joint School, Bellwood	★	★	★	★	★		★	★	★				
Conestoga Senior High School, Berwyn								★	★	★	★	★	
McDowell High School, Erie*								★	★	★			
Westminster Junior High School, Erie*	★	★	★				★						
Grove City Junior High School, Grove City	★	★	★			★	★						
Grove City Senior High School, Grove City								★	★	★			
General Wayne Junior High School, Malvern	★	★	★	★	★	★	★						
Scott High School, North Braddock								★	★	★			
Cooke Junior High School, Philadelphia*	★	★	★				★						
Gratz High School, Philadelphia*								★					
Olney High School, Philadelphia*								★	★	★			
South Philadelphia High School, Philadelphia*								★		★			
Vare Junior High School, Philadelphia*	★	★	★				★						
Vaux Junior High School, Philadelphia*	★	★	★				★						
Castle Shannon Junior High School, Pittsburgh*	★	★				★							
Dormont High School, Pittsburgh*							★	★	★				
Saint Patrick High School, Scranton*	★	★					★		★	★			
Turtle Creek High School, Turtle Creek								★	★	★			
Turtle Creek Junior High School, Turtle Creek	★	★	★			★	★						
Big Bend Grade School, Twin Rocks	★	★											
Blacklick Township High School, Twin Rocks			★				★	★	★	★			
South Carolina													
Great Falls High School, Great Falls	★	★	★				★		★				
Tennessee													
Dickson Elementary School, Dickson	★	★											
Dickson High School, Dickson			★				★	★	★	★			
La Follette High School, La Follette			★				★		★				
East High School, Memphis*	★	★						★	★				
Longview Junior High School, Memphis*	★	★											
South Side High School, Memphis*			★				★	★	★				
Texas													
Bassett intermediate School, El Paso*	★	★		★	★	★							
Stephen F. Austin High School, El Paso*			★				★	★	★	★	★	★	
Aldine Junior High School, Houston*	★	★	★			★	★						
Aldine Senior High School, Houston*								★	★				
Stephen F. Austin High School, Houston*									★	★			
Stonewall Jackson Junior High School, Houston*	★	★	★			★		★					
Lubbock High School, Lubbock*								★	★	★			
R. W. Matthews Junior High School, Lubbock*	★	★	★				★						
Navasota Elementary School, Navasota	★	★											
Navasota High School, Navasota			★				★	★	★				
Vermont													
Main Street School, Montpelier	★	★											
Montpelier High School, Montpelier			★				★	★	★	★			
Mount Saint Joseph Academy, Rutland			★				★	★	★	★	★		
Saint Peter's School, Rutland	★	★											
Virginia													
Stratford Junior High School, Arlington	★	★	★	★	★	★	★						
Washington-Lee High School, Arlington								★	★	★	★	★	★
Fieldale Elementary School, Fieldale	★												
Fieldale High School, Fieldale		★	★				★	★	★	★			
George W. Carver Elementary School, Newport News*	★												
George W. Carver High School, Newport News*		★	★			★	★	★	★				
Norview High School, Norfolk*								★	★	★			
Norview Junior High School, Norfolk*	★	★	★			★	★						
Saint Patrick Central High School, Richmond*						★			★	★			
Saint Patrick Central Junior High School, Richmond*	★												
Fishburne Military School, Waynesboro							★	★	★	★			

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*Denotes schools in the Urban Norms where provided.

TABLE 55 (*Continued*). Schools Included in the National Norms

School	Arithmetic			No. System		Alg. I		Alg. II	Geom.	Trig.	Alg. III	Analyt. Geom.	Calc.
	7	8	9	7	8	8	9						
Washington													
George Washington Junior High School, Seattle*	★	★	★	★			★						
Highline High School, Seattle*								★	★	★	★		★
James A. Garfield High School, Seattle*								★	★	★			
Seahurst Junior High School, Seattle*	★	★	★				★						
West Virginia													
Barboursville Junior High School, Barboursville	★	★	★			★	★						
Roosevelt-Wilson High School, Clarksburg	★	★	★				★	★	★				
Wisconsin													
Henry Clay Junior High School, Milwaukee*	★	★											
Whitefish Bay High School, Milwaukee*			★			★	★	★	★	★			
Park Falls High School, Park Falls			★				★	★	★	★		★	
Saint Anthony School, Park Falls	★	★											
Newbold Elementary School, Rhinelander	★	★											
Rhinelander Union High School, Rhinelander			★				★	★	★			★	
Shiocton Joint School No. 2, Shiocton	★	★					★		★				
Valders Graded School, Valders	★	★											
Valders High School, Valders							★	★	★				
Central High School, West Allis								★	★	★			
Horace Mann Junior High School, West Allis	★	★	★			★							

*Denotes schools in the Urban Norms where provided.

TABLE 56. Colleges Included in the National Norms

College	Trigonometry	Algebra III	Analytical Geometry	Calculus
Alabama				
Sacred Heart College, Cullman		★		★
Spring Hill College, Mobile	★	★	★	★
Arizona				
Arizona State University, Tempe	★	★	★	★
California				
Compton District Junior College, Compton	★	★		★
Diablo Valley College, Concord	★	★	★	★
Fresno City College, Fresno	★	★	★	
Foothill College, Los Altos Hills	★	★	★	★
East Los Angeles College, Los Angeles	★	★	★	★
Modesto Junior College, Modesto	★	★	★	★
College of the Holy Names, Oakland	★		★	★
Reedley College, Reedley	★	★		★
Riverside City College, Riverside	★			
San Bernardino Valley College, San Bernardino	★		★	
Palomar College, San Marcos	★	★		★
Contra Costa College, San Pablo		★	★	★
Westmont College, Santa Barbara			★	★
Vallejo Junior College, Vallejo	★	★		★
College of the Sequoias, Visalia	★	★	★	★
Mount San Antonio College, Walnut	★	★		★
Connecticut				
Wesleyan University, Middletown				★
Florida				
Manatee Junior College, Bradenton	★	★		
Georgia				
Fort Valley State College, Fort Valley	★		★	
Georgia Southern College, Statesboro	★	★	★	★
Idaho				
College of Idaho, Caldwell				★
Ricks College, Rexburg	★	★	★	★

TABLE 56 *(Continued)*. Colleges Included in the National Norms

College	Trigonometry	Algebra III	Analytical Geometry	Calculus
Illinois				
Belleville Junior College, Belleville	★	★	★	
Chicago City Junior College, Chicago	★	★	★	★
Saint Xavier College, Chicago	★		★	★
Northern Illinois University, De Kalb	★	★	★	★
Elgin Community College, Elgin	★	★		★
Elmhurst College, Elmhurst	★			★
Lake Forest College, Lake Forest	★	★		
Black Hawk College, Moline	★	★	★	★
Indiana				
Anderson College and Theological Seminary, Anderson				★
Goshen College, Goshen			★	
DePauw University, Greencastle		★		★
Iowa				
Luther College, Decorah	★		★	
Keokuk Community College, Keokuk				★
Wartburg College, Waverly	★	★	★	★
Kansas				
Kansas State Teachers College, Emporia	★	★	★	★
Kansas State College of Pittsburg, Pittsburg	★	★	★	★
Washburn University of Topeka, Topeka	★	★	★	★
Kentucky				
University of Louisville, Louisville	★	★	★	★
Louisiana				
Southeastern Louisiana College, Hammond	★	★	★	★
McNeese State College, Lake Charles	★	★	★	★
Maryland				
State Teachers College at Towson, Baltimore	★		★	
Essex Community College, Essex	★			
Michigan				
Highland Park Junior College, Highland Park	★	★		★
Hope College, Holland	★		★	★
Missouri				
Northeast Missouri State Teachers College, Kirksville				★
Southwest Missouri State College, Springfield	★	★	★	★
Central Missouri State College, Warrensburg	★		★	★
New Jersey				
Trenton State College, Trenton			★	★
New York				
State University of New York, Cortland				★
Saint John's University, Jamaica	★	★	★	★
Staten Island Community College, Staten Island				★
Good Counsel College, White Plains	★			★
North Carolina				
Agricultural and Technical College of North Carolina, Greensboro	★	★	★	★
Wingate College, Wingate	★	★	★	★
Ohio				
Kent State University, Kent				★
Oregon				
Oregon College of Education, Monmouth	★		★	★
Pennsylvania				
Franklin and Marshall College, Lancaster				★
Mount Mercy College, Pittsburgh	★		★	★
Lycoming College, Williamsport	★	★	★	★

TABLE 56 *(Continued)*. Colleges Included in the National Norms

College	Trigonometry	Algebra III	Analytical Geometry	Calculus
South Carolina				
Clemson Agricultural College, Clemson	★	★	★	★
University of South Carolina, Columbia	★	★	★	
Tennessee				
Middle Tennessee State College, Murfreesboro	★	★	★	★
Texas				
Amarillo College, Amarillo		★		
Frank Phillips College, Borger	★	★	★	★
University of St. Thomas, Houston				★
San Antonio College, San Antonio	★	★	★	★
Virginia				
Emory and Henry College, Emory	★	★	★	★
Eastern Mennonite College, Harrisonburg	★	★	★	★
Virginia State College, Petersburg	★		★	★
Washington				
Holy Names College, Spokane		★		★
West Virginia				
Morris Harvey College, Charleston	★	★	★	★
West Virginia University, Morgantown	★	★		★
Wisconsin				
Beloit College, Beloit	★			

TABLE 57. Schools Included in the Suburban Case Study

School	Arithmetic			Algebra I		Algebra II	Geometry	Trigonometry
	7	8	9	8	9			
Missouri								
Clayton High School, Clayton					★	★	★	★
Maryland Elementary School, Clayton	★							
Wydown School, Clayton		★		★				
Kirkwood High School, Kirkwood						★		★
North Kirkwood Junior High School, Kirkwood			★	★	★			
New York								
Manhasset High School, Manhasset						★	★	★
Manhasset Junior High School, Manhasset	★	★	★		★			

Schools and Colleges Which Tested Whose Results Were Not Included in the Data

The Cooperative Test Division wishes to acknowledge the cooperation of the following schools and colleges in administering appropriate tests; however, all or part of their results were not included in the final data. (*See page 58.*)

Schools: A. H. Parker High School, Birmingham; Thomas Elementary School, Birmingham; Catalina High School, Tucson; Samuel Gompers Junior High School, San Diego; McNicol Junior High School, Hollywood, Fla.; Northside High School, Atlanta; Mount Carmel High School, Chicago; Quincy Junior High School, Quincy, Ill.; John F. Nuner Junior High School, South Bend; Rayne High School, Rayne, La.; Middlesex School, Concord, Mass.; Chapel Hill School, Waltham, Mass.; Saint Leo High School, Detroit; Vandercook Lake High School, Jackson, Mich.; Kirkwood High School, Kirkwood, Mo.; North Kirkwood Junior High School, Kirkwood, Mo.; Beaumont High School, St. Louis; Notre Dame High School, Trenton; Wagon Mound High School, Wagon Mound, N.M.; Thomas Jefferson High School, Brooklyn; Washington Irving High School, New York; Our Lady of Lourdes High School, Poughkeepsie; Garinger High School, Charlotte; Kiser Junior High School, Greensboro, N.C.; Orrville Junior High School, Orrville, Ohio; East High School, Memphis; Barboursville High School, Barboursville, W. Va.; Shiocton Joint School No. 2, Shiocton, Wisc.

Colleges: Fresno City College, Calif.; Riverside City College, Calif.; Palomar College, Calif.; Contra Costa College, Calif.; University of Denver; Fort Valley State College, Ga.; Lake Forest College, Ill.; North Central College, Ill.; Anderson College and Theological Seminary, Ind.; Keokuk Community College, Iowa; Nebraska Wesleyan University; Saint Michael's College, N.M.; State University of New York, Cortland; Iona College, N.Y., George Peabody College for Teachers, Tenn.; Virginia State College.

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Outside ETS—

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Item writers (many of whom also served as reviewers): Arithmetic—**Robert Kalin,** Florida State University (with **Tom Denmark, Barbara Toney,** and **Mark Whittaker**); **Nicholas Lovdjieff,** Susan B. Anthony Jr. H.S., Minneapolis; **Eugene Nichols,** Florida State University; **Lyman Peck,** Ohio Wesleyan University; **Agnes Rickey,** Miami Public Schools, Florida; **Myron Rosskopf,** Columbia University; **Raymond Walch,** Bedford Junior High School, Westport, Connecticut. *Structure of the Number System*—**J. Houston Banks,** George Peabody College for Teachers; **Nathan Fine,** University of Pennsylvania; **Burton W. Jones,** University of Colorado. *Algebra I*—**Alexander Beck,** Olney High School, Philadelphia; **Vincent Haag,** Franklin and Marshall College; **Stanley Jackson,** University of Maryland; **William Lowry,** University of Virginia. *Algebra II*—**Mary Dolciani,** Hunter College; **Virginia Terhune,** Proviso East High School, Proviso, Illinois; **H. C. Trimble,** Iowa State Teachers College (with **Irvin Brune, Jens Jensen**). *Geometry*—**Max Beberman,** University of Illinois; **H. C. Christofferson,** Miami University, Ohio; **Clarence Heinke,** Capital University; **Bruce Meserve,** New Jersey State Teachers College, Upper Montclair; **Myron Rosskopf,** Teachers College, Columbia University; **John Schacht,** Bexley High School, Bexley, Ohio; **Harry Sitomer,** New Utrecht High School, Brooklyn; **Edward Whitmore,** San Francisco State College. *Trigonometry*—**Richard Andree,** University of Oklahoma; **Harry D. Ruderman,** Hunter College High School, New York; **E. P. Vance,** Oberlin College; **Robert C. Yates,** University of South Florida. *Algebra III*—**Peter Lappan,** Notre Dame University; **Charles Saikind,** Polytechnic Institute of Brooklyn; **William Wooton,** Pierce Junior College, Woodland Hills, California. *Analytic Geometry*—**Helen Marston,** Douglass College; **Abba Newton,** Vassar College; **Cletus Oakley,** Haverford College; **Harry D. Ruderman,** Hunter College High School, New York. *Calculus*—**Richard Andree,** University of Oklahoma (with **Mrs. Andree**); **Winifred Asprey,** Vassar College; **R. Chreighton Buck,** University of Wisconsin (with **Mrs. Buck**); **M. Albert Linton, Jr.,** William Penn Charter School, Philadelphia; **Ransom Van B. Lynch,** Phillips Exeter Academy; **Charles Pinzka,** University of Cincinnati; **Robert Rosenbaum,** Wesleyan University, Connecticut (with **Louise J. Rosenbaum**).

Reviewers: **Walter A. Albrecht, Jr.,** Long Beach State College; **H. Glenn Ayre,** Western Illinois State College; **Grover C. Bartoo,** Western Michigan University; **Ralph Beatley,** Harvard University; **Harry Benz,** Ohio University; **Paul W. Berg,** Stanford University; **James A. Bewley,** Junior High School No. 2, Trenton, New Jersey; **Shirley E. Boselly, Jr.,** Franklin High School, Seattle; **Dalga Brilliantine,** Junior High School No. 2, Trenton, New Jersey; **Florence M. Burke,** Princeton High School, Princeton; **John W. Cell,** North Carolina State College; **Richard D. Crumley,** Iowa State Teachers College; **Floyd L. Downs,** Kent School, Kent, Connecticut; **Frederick W. Drewes,** Trenton Central High School, New Jersey; **W. E. Ferguson,** Newton High School, Massachusetts; **Robert S. Fouch,** Florida State University; **Helen Garstens,** University of Maryland; **H. M. Gehman,** University of Buffalo; **Glenadine Gibb,** State College of Iowa; **William Glenn,** Pasadena City Schools; **Gordon Glabe,** Sacramento State College; **Richard A. Good,** University of Maryland; **Harold S. Grant,** Rutgers University; **Gerald Groninger,** Princeton High School, Princeton; **Clarence Hardgrove,** Northern Illinois University; **Julius Hlavaty,** DeWitt Clinton High School, New York; **Stanley P. Hughart,** Sacramento State College; **Lenore John,** University High School, University of Chicago; **Donovan A. Johnson,** University High School, University of Minnesota; **Mildred Keiffer,** Cincinnati Public Schools; **Ruth Law,** Valley Road School, Princeton; **L. Clark Lay,** Pasadena City College; **Solomon Leader,** Rutgers University; **H. David Lipsich,** Stanford University; **Harold T. Lundholm,** The Blake School, Hopkins, Minnesota; **William W. Matson,** Portland Public Schools, Oregon; **Carol V. McCamman,** Calvin Coolidge High School, Washington, D. C.; **L. H. Miller,** Ohio State University; **Edwin E. Moise,** University of Michigan; **Mary S. Morehart,** Columbus, Ohio; **Arthur Ollivier,** Mississippi State University; **David Page,** University of Illinois; **John G. Pocock,** Milton Academy, Massachusetts; **Walter Prenowitz,** Brooklyn College; **G. Bailey Price,** University of Kansas; **U. Frank Rago,** Junior High School No. 5, Trenton, New Jersey; **Ernest Ranucci,** State Teachers College, Union, New Jersey; **John Reckzeh,** State Teachers College, Jersey City, New Jersey; **Paul Reichelderfer,** Ohio State University; **Katherine K. Rider,** Princeton High School, Princeton; **Mary C. Roger,** Edison Junior High School, Westfield, New Jersey; **Max Sobel,** State Teachers College, Montclair, New Jersey; **Ben Sueltz,** State University of New York, Cortland; **Henry Swain,** New Trier Township High School, Winnetka, Illinois; **R. H. van der Linne,** Bennington College; **J. Fred Weaver,** Boston College; **Robert Wilson,** Ohio Wesleyan University; **Jack M. Wolfe,** Brooklyn College.

Schools and colleges participating in experimental test administrations: see Tables 53-54.

Schools and colleges participating in norming and equating administrations: see Tables 55-57.

Inside ETS—

Test development: **Marion G. Epstein, Jane E. Lambert, Sheldon S. Myers, Eleanor Wilkinson.**

Advisers: **William E. Coffman, Paul B. Diederich, Robert Ebel, S. Donald Melville, William B. Schrader, Robert J. Solomon.**

Statisticians: **Bonnie S. Laudan, Frances Swineford, Madeline M. Wallmark.**

Statistical directors: **William H. Angoff, Donald A. Trismen.**

Editorial and administrative assistants: **Anne Davis, Lynn K. Gaines, Karen Raymond, Louise Ritenour, Rosemary Russell, Gray Sidwell.**

Project directors: **Dolores F. Ahrens, Scarvia B. Anderson.**

APPENDIX B

NORTHEASTERN REGIONAL
TELEVISION LIBRARY PROJECT
EASTERN EDUCATIONAL NETWORK

TASK III
IN-SERVICE MATHEMATICS SERIES FOR TEACHERS

INSIGHTFUL ARITHMETIC AND UNIT TESTS

SUPERVISOR'S MANUAL

PART 1 -- General Instructions

PART 2 -- Specific Instructions to be read to the candidates

1963-1964 Administrations

Insightful Arithmetic Test		
	Approximate Total Time:	120 minutes
PART 1		60 minutes
PART 2	Approximately	60 minutes
End-of-Telecast Unit Tests (each test)		
	Approximate Total Time:	35 minutes
PART 1 (each test)		30 minutes
PART 2 (each test)	Approximately	5 minutes

EDUCATIONAL TESTING SERVICE
Princeton, New Jersey, 08540

Receipts Processing: Route to Developmental Research Division, T-125

INSIGHTFUL ARITHMETIC AND UNIT TESTS

SUPERVISOR'S COMMENTS

If you have comments or suggestions for improvements or refinements in our testing procedures, please write them in the space below. You are certainly under no obligation to comment, but we want you to know that all suggestions are appreciated. Our present Manuals and procedures incorporate many ideas suggested to us in the past by supervisors.

Please use a pencil or typewriter if you comment on this form and fill in the information requested at the bottom of the page. The form may be returned with used answer sheets. While all comments are reviewed by our staff, only those obviously calling for a reply will be answered.

Be sure to note all irregularities on the Irregularity Report.

Name ______________________ Administration Date ______________________

School ______________________ City and State ______________________

Position ______________________

Business Phone ______________________

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      - Check List - Equipment Supplied by You
    - Admission to the Tests
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1963-1964 ADMINISTRATIONS

PART 1

GENERAL INSTRUCTIONS FOR THE ADMINISTRATION of the NORTHEASTERN REGIONAL INSTRUCTIONAL TELEVISION LIBRARY PROJECT IN-SERVICE MATH TESTS (ETS)

Systematic procedures are essential in a research program that involves testing at many centers. The scores of all candidates tested will be comparable only if all supervisors adhere to the same schedule and administer all the tests in exactly the same way. You should therefore be thoroughly familiar with these instructions before the day the tests are actually given and then follow all of them exactly.

As supervisor, your primary concern should be: (1) to safeguard the aspects of security of the tests, (2) to conduct the tests efficiently and quietly, (3) to protect the candidates from disturbance, (4) to return the test materials promptly, and (5) to maintain the confidentiality of information gained from candidates as a result of administering these tests.

To aid you in administering the tests, two publications have been prepared for you and your assistants; they must be studied until their contents are familiar:

1. the Supervisor's Handbook, a comprehensive guide to tests administered by the Educational Testing Service
2. this Supervisor's Manual, a detailed account of information and instructions for the supervisor and his assistants for the day the test is actually given and for the specific testing program

Most of the necessary contacts between supervisors and ETS can be handled by correspondence; sometimes it is advisable to telephone ETS when circumstances call for prompt action. Such calls should be directed as follows:

Princeton Office Telephone
Area Code 609, 921-9000, Extension 559

Equipment for the Administration

The equipment you will need for administering the test in addition to the test books and an Attendance Roster, furnished by ETS, is on the following list (with check boxes for your convenience). This material should be checked and verified when the initial shipment of test materials is received.

Check List - Equipment Supplied by ETS:

( ) 1. Supervisor's Manual

a. Supervisor's Irregularity Report (last page)
b. Supervisor's Comments Sheet

( ) 2. Supervisor's Handbook

( ) 3. Supervisor's Report Forms

( ) 4. Postage-paid envelopes for the return of answer sheets and/or test books to ETS

( ) 5. Emergency supply of electrographic pencils

Check List - Equipment Supplied by You:

( ) 1. A reliable watch which you are willing to adjust as the instructions require

( ) 2. A clock (alarm clock size or larger), in the event that there is no clock in the examination room - if this is not possible, you can post the amount of time remaining at various intervals

( ) 3. At least two electrographic pencils for each candidate, and a pencil sharpener - your school system has already been supplied with electrographic pencils by ETS for earlier testing in this project and an additional quantity will accompany each test shipment to your Pilot Center coordinator

Admission to the Tests

You will have supplies for all those candidates who are listed on the Attendance Roster, plus an overage. After admitting all candidates who are listed on the Attendance Roster, you may admit the remaining candidates in the following order as long as your surplus supplies last:

1. Admit those candidates who are not on the Attendance Roster, but who are teachers (or pupils of teachers) regularly enrolled in a Pilot Center group (with or without college or university or certification credit). Add names to Attendance Roster.

2. Admit those candidates who are not on the Attendance Roster, but who are teachers (or pupils of teachers) who plan to enroll in a Pilot Center group (with or without college or university or certification credit). Add names to Attendance Roster.

The following rule is of the utmost importance: You must add to the Attendance Roster the name of any candidate admitted to the tests who is not listed.

Test Security

The security of all tests is the responsibility of the test supervisor from the moment of their receipt until they are returned to ETS. This means that no one is to have the opportunity to examine any test book at any time, except the candidate as he takes the test. Any breach of security, no matter how minor, must be reported to ETS at once. Supervisors should phone collect (see page 4). No candidate is to be dismissed before this is done.

Closing the Testing Room

The doors of the room in which the test session is held are to be closed at the announced time for the start of the administration. Candidates who arrive a few minutes late may be admitted at the discretion of the supervisor, provided the actual test administration has not begun. Under ordinary circumstances no candidate should be admitted after the actual testing has begun; if you decide to admit a candidate who has been delayed for some valid reason (see Supervisor's Handbook), you must assume the responsibility of giving him the full testing time. A late-comer must not be permitted to finish with those candidates who started on time. Explain fully on your yellow Irregularity Report.

Distribution and Handling of Test Materials

You have received (or will shortly receive) test books arranged in order of their serial numbers. Distributing and collecting books in this order within each room will facilitate your accounting for all test materials. If you use more than one room, you should keep a record of the serial numbers issued to each of your assistants.

After all candidates have been admitted and seated according to one of the seating plans in the Handbook, give a test book to each candidate individually - each candidate must receive only one test book. No one except a candidate is allowed to break the seal on or to examine the contents of a test book unless it is necessary for you to look one over for defects.

While taking a test, the candidate should have nothing on his desk but his test book, answer sheets supplied by ETS, and his electrographic pencils - no rulers, compasses, protractors, slide rules, or dictionaries. The use of scratch paper is prohibited - any preliminary work can be done in the margins of the test book.

The form number for the Test is printed in the upper right-hand corner of the test book and immediately under the title of the test in the upper right-hand corner of the answer sheet.

If a test book is found to be defective, you should break the seal of a new test book with the same form number and remove the answer sheet. Direct the candidate to write his name on the cover of the new test book and to continue the test using his original answer sheet.

Be sure to report the incident on your Irregularity Report.

If the answer sheet is found to be defective, give the candidate a new one from a test book with the same form number, direct him to write his name on the new answer sheet and to continue with the test. Clip both answer sheets together and return to ETS with an explanation attached.

Be sure to report the incident on your Irregularity Report.

Count of Test Materials

You should determine within the first half hour of each test session the number of candidates taking the test and the number of unused test books (plus defective test books, if any); together they should equal the number of test books you received from ETS. (There are twenty (20) books in each bag.) Since you are responsible for returning the full number to ETS, you must be certain that you have every test book sent you - before the candidates leave the room.

In the event there is a discrepancy, permit the candidates to finish the section on which they are working when it is noted. When they finish this section, stop the testing. Inform the candidates that one of them has been given an extra test book by accident and request that it be returned to you. When the test book is handed in, resume the test. The circumstances should be reported on your Irregularity Report.

If the test book is not handed in, resume testing, place the room in an assistant's charge, and report the circumstances by phone to ETS. Call collect. Phone: Princeton, New Jersey, Area Code 609, 921-9000, Extension 559.

Attendance

It is vitally important that the Attendance Roster be correct and complete; the individual candidate's presence or absence must be indicated opposite his name on the Roster. If you admit any candidates who are not listed on the Roster, their names must be added.

Smoking

Smoking regulations which apply to the building or room in which the testing is done should be strictly enforced during administration of the test.

Information on Guessing

If a candidate asks you about guessing, refer him to the statement of instructions for the test. There is also a section in Part 2 of this Supervisor's Manual regarding guessing and assistance you may give a candidate during testing. There should be no deviation from these instructions.

Routine Absence

A candidate may go to a rest room during the rest period. Make sure that he has left his test book on his desk with his answer sheet inside the front cover. Two or more candidates should be accompanied by an assistant.

A candidate may also go to the rest room during actual testing time; his test book and answer sheet should be collected and the same test materials returned to him. Two or more candidates should be accompanied by an assistant.

No extra testing time may be allowed for a routine absence and it need not be entered on the Irregularity Report.

Irregularities of Administration

The following irregularities of administration should be reported on your Irregularity Report which appears at the back of this Manual. Be sure to indicate the section for any irregularity which occurs.

Group Irregularities: (Please enter section affected.)

Mistimings

Mistimings should be reported in the area reserved for this type of irregularity. Undertiming should be corrected during the administration before the candidates are dismissed. (See also Supervisor's Handbook, page 19.)

Emergencies

Emergencies over which you have no control, such as flood, snowstorm, power failure, or extraneous activity that disturbs the candidates should be reported on the lower part of the "Group Irregularities" section of the Irregularity Report. (See Supervisor's Handbook, page 17.)

Individual Candidate Irregularities: (For each candidate, please enter all identifying information: name, test book number, section, time by reset watch, in the boxes provided.)

Defective Test Materials

If either answer sheet or test book is found to be defective, give the candidate a new sealed test book. Direct him to write his name on the new test book, break the seal, remove the answer sheet, and write only his name on the new answer sheet, starting with the question numbered the same as the one he stopped working on in the first test book. Attach both answer sheets to the Irregularity Report and return to ETS. Record candidate's identifying information, check the defective material box at left and explain further under "Remarks." If defective materials cause a loss of time, check the mistiming column also and note time by reset watch in the last column. Defective test books should be returned in an answer sheet envelope, with a note attached.

Candidate Mistiming

If a candidate is detected working on the wrong section of a test, the proctor (or the supervisor) must instruct the candidate to proceed to the correct section. Record identifying information for candidate, check the mistiming box at left, and under "Remarks" enter:

Worked ___________minutes on section ___________, missed that time on section ___________.

Absence due to illness

If a candidate becomes ill during the test, his test book and answer sheet should be collected. If he is able to return, he is to be given the same test materials. No extra testing time may be allowed.

Record identifying information for candidate, check the illness box at left, and under "Remarks" enter:

Left room for ____ minutes because of (type of illness).

Returned to room at (time by reset watch).

If a candidate must withdraw permanently from the test because of illness, you should collect his test materials and record identifying information for candidate, check the illness box at left, and under "Remarks" enter:

Left room at (time by reset watch). Forced to leave because of (type of illness).

Cheating

The cooperation you as a supervisor secure from the candidates before and during testing should minimize the incidence of cheating. However, if you are convinced beyond a reasonable doubt that a candidate is giving or receiving assistance during an examination, his test book and answer sheet are to be returned to ETS with a note of explanation written on the Irregularity Report. Every candidate's score lost as a result of cheating, may mean loss of that person as a valid subject for research based upon this phase of the testing procedure. Record identifying information for candidate, check the cheating box at left and explain the circumstances under "Remarks." (See also Supervisor's Handbook, pages 18-19.)

Other Irregularities

Some candidates mark the answers in the test book instead of on the answer sheet and some misplace the answers on the answer sheet. (See Supervisor's Handbook, page 20.) All such cases reported or detected should be entered on the "Individual Candidates Irregularities" section of the Irregularity Report by recording the candidate's identifying information and checking the "other" box at left. Enter a brief explanation under "Remarks." Attach answer sheet and test book (if answers appear in test book and not on the answer sheet) to the Irregularity Report and send to ETS.

Record all cases of failure to follow directions on the Irregularity Report.

Collection of Test Materials

When the candidates have been told to close their test books at the end of the time allowed for the test, you and/or the assistants are to collect the test books and answer sheets individually from each candidate as outlined in the "Specific Instructions" inserted in this Manual. In order to insure the cooperation of the candidates until all test materials have been collected, it is essential that the answer sheets, which are of primary importance to the candidates, be collected last, unless otherwise directed in the "Specific Instructions" inserted in this Manual.

Before the candidates are dismissed, a complete count of all test books and answer sheets (used, unused, and defective) must be made and verified. If the candidates have followed directions properly, their full names are printed in the upper left corner of the front cover of their test books. When verifying the count, you can match the test books with answer sheets, enabling you to find out which candidate's testbook is missing.

When all materials which were sent to you from ETS are in your possession, dismiss the candidates. The collected test material should be placed where the candidates will not have access to it as they leave the room.

The following rule must be enforced: no one is allowed to examine the test books or the answer sheets after they have been returned to you.

Dismissal

No candidate may leave the test center before time is called, except in case of illness. It it important that every candidate be reassured frequently that individual scores will not be reported to anyone other than himself.

DETAILED INSTRUCTIONS FOR RETURN OF TESTING MATERIALS

You are asked to adhere strictly to the following instructions in order to prevent any delays or mistakes in the return of materials. We suggest that you use the check list to be certain that everything necessary has been done.

Return of Answer Materials and Allied Information

The materials listed below are to be returned immediately after the administration of the test in the postage-paid envelopes provided, to ETS, Princeton, New Jersey 08540. Do not use registered mail - deposit in any mailbox as soon as possible. The name of the supervisor, the center at which the test was administered, and the address of the center must be written in the upper left corner of the envelope.

It may be to the advantage of the candidates and the project if the supervisor places these materials in the envelopes and seals the envelopes in the presence of the candidates prior to dismissal of the candidates from the testing room.

Check List - Answer Materials:

( ) 1. Used test answer sheets and completed Supervisor's Report

( ) 2. Used test books where specified in the "Specific Instructions" inserted in this Manual

( ) 3. Completed Final Shipment Notice with "Number of Candidates" entered

( ) 4. Completed Attendance Roster

( ) 5. Completed Irregularity Report, if any irregularities

( ) 6. Supervisor's Comments Sheet, if any comments have been made

Return of Test Books and All Remaining Materials

The materials listed below are to be sent Railway Express collect, promptly after the administration of the test, with a declared value of $50.00 on the entire shipment, to ETS Shipping Center, Princeton, New Jersey 08540. Paste the return label over the printed address label on the shipping carton. Be sure to enter the name of the test center which appears on the Shipment Notice, in the appropriate block and print it as large as possible to facilitate checking returned materials. Keep your copy of the Railway Express Shipping Receipt for at least three months.

Check List - Test Books:

( ) 1. Used test books unless specified otherwise in the "Specific Instructions" inserted in this Manual

( ) 2. Unused test books

( ) 3. Unused postage-paid envelopes

1963-1964 Administrations

PART 2B

SPECIFIC INSTRUCTIONS TO BE READ TO THE TEACHERS
FOR THE ADMINISTRATION OF THE
UNIT TESTS
FORMS LTIZ5 to LTIZ9

Total Testing Time - 40 minutes

This leaflet, which is inserted in the General Instructions, contains the specific instructions for the Unit Test, Forms LTIZ 5 to LTIZ 9. All the directions which you are to read aloud to the teachers are enclosed in boxes. You are not to depart from these directions nor to answer questions regarding the content of the test. Seat the candidates according to your prearranged plan.

At the back of this leaflet is a reproduction of the answer sheet to be used for these tests. This reproduction has been included so you may clearly understand the instructions for filling in the required information on the answer sheet - it is for reference purposes only.

When you and the teachers are ready to begin, and before you distribute any test material, say:

> Each of you will now be given a sealed test book. I will read the directions to you. Do not break the seal until I tell you to do so . . . .

Distribute a unit test book to each teacher individually. Distribute sharpened electrographic pencils, two to each teacher. Check to see that all teachers have pencils. Make sure no seals are broken by the teachers. Read the boxed material which follows, pausing when 4 dots . . . . appear and allow the appropriate amount of time for the procedure described to be carried out.

Now say:

> In the upper left corner of the front cover of your test book, print your name in exactly the same form as you will be using it throughout this testing program, last name first . . . . Using the eraser end of your pencil, break the seal on your test book from the inside. Take out the answer sheet you find inserted and close your test book immediately . . . . Do not fill in any of the blanks on your answer sheet until I tell you what to do. Place your answer sheet so that the heading, "NRITLP - Sets and Systems, Achievement Test Unit (number of unit test) is at theupper right-hand corner (demonstrate). In the first space provided, print your name in exactly the same way it is printed on the front cover of

your test book, last name first. . . . .
In the space provided on the same line, print today's date (write the date on the blackboard so that it is plainly visible to all teachers) ....
On the next line, print the name of the school at which you are teaching and its address by city and state only . . . .
In the space provided on the third line (demonstrate), write the grade level you are teaching . . . .
Now sign your name in the space provided (demonstrate) . . . .
Check to see that the number in the upper left-hand corner of your answer sheet is the same as that on the front cover of your test book (assist by demonstration) . . . .
The form designation written in the upper left-hand corner of your answer sheet and on the test book cover (demonstrate) should be the form of the test being used. If either the test book and answer sheet number or the form designation do not agree, please raise your hand (correct and proceed) . . . .
Are there any questions? . . . .

Answer all questions, Then say:

Now turn your answer sheet so that the information you have printed on it is at your left (demonstrate). You will have 30 minutes to work on the first section of this test. If you finish before time is called, continue with the second section of the test. There are two sections. You are asked not to omit either section.
You are to mark answers to all questions of the first section on the answer sheet. Be sure that all your answers are black and that they completely fill the boxes. Do not make any stray marks on your answer sheet. If you erase, do so

completely. Incomplete erasures might be read as intended answers. Be sure that for every box you blacken on your answer sheet, the number there corresponds to the number of the question you are answering. Do not be concerned if there are more answer boxes than you need. If your pencil breaks, raise your hand, and then continue working on the test with the other pencil. We will give you another pencil. Do not use any pencil other than one given you by us to mark your answer sheet. As you know, scratch paper is not permitted. Scratch work may be done in the test book. The results of your work must be recorded by blackening the appropriate box on the answer sheet and circling the correct answer in your test book.

You are to ask no questions during the test. If your test book or answer sheet or pencil is defective, raise your hand. Keep your answer sheet flat on your desk directly in front of you during the test. Now remove all materials other than the test book, the answer sheet and your special pencils from your desk . . . .
Remember you are to ask no questions during the test so you must ask them now. Are there any questions? (Defer answering questions concerning the second section of the test until the teachers are ready for this section) . . . .

After all questions on procedure have been answered, set your watch at 2:59. When your watch reads exactly 3:00, say:

You will have 30 minutes to work on the first section of this test. If you finish before time is called, continue with the second section of the test. Open your test book, read the directions, and begin work.

Circulate quietly about the room, checking the names on the answer sheets with your roster of candidates. After each candidate's name on the roster, write his or her examination number. This will help in matching examinees to test book numbers and in checking on the use of supplies as indicated in the General Instructions. At the end of exactly 30 minutes, say:

Stop. Close your test book and keep it closed on your desk. Do not insert your answer sheet in your test book. Make sure that you have given all the information requested on your answer sheet . . . .

Look over each mark on the answer sheet to be sure it is black and completely fills the box. Erase any stray marks . . . .

Check the cover of your test books to see that you have printed your full name, last name first, in the upper left corner in the same form as it appears on your answer sheet . . . .

We will now collect the answer sheets and place them in one of these envelopes (demonstrate). The envelopes will be sealed and mailed directly to Educational Testing Service.

AT 3:20

After the answer sheets have been collected, and inserted in the Business Reply envelopes provided and after the envelopes have been sealed in the presence of all candidates, say:

The second section of this test asks from you information which will help people working on this project in interpreting the meaning of scores you made on the first section of this test and on other tests you will be taking this year. In order to make this information most meaningful, each person taking the test should complete as much of Section Two of this test as possible. You may ask questions concerning this portion of the test, but the answer to each question on the test must ultimately be yours and not that of someone else. While you are completing this part of the test, we will pass out to each of you an envelope in which to place a part of your test book when you have finished with it. Please wait for further instructions.

Distribute the Business Reply Envelopes, and then say:

> May I have your attention, please? I have distributed to each of you a Postage-paid envelope. Please complete Section two at home, place your test book in the envelope and mail it to ETS within the next week. No postage is required.

When completely sure all materials belonging to ETS and for which you are responsible are in your possession, proceed with the seminar as scheduled. As soon as the seminar is over and the candidates have left the room, you should fill out your Supervisor's Report forms for the Unit Test. If at all possible, you should mail all used Unit Test answer sheets and the appropriate report forms to ETS at the end of the testing and seminar session. Please follow the directions for mailing given on Page 11, General Instructions. All test materials not returned to ETS at the end of the testing session should be returned as soon as possible.

APPENDIX C

Form Number OE - 2159

Budget Bureau Number 51 R 448
Approval Expires December 31, 1964

EDUCATIONAL TESTING SERVICE PRINCETON, N. J.

Developmental Research Division

INSTRUCTIONAL ACTIVITIES SURVEY
Part I - ELEMENTARY MATHEMATICS
857.02 - February, 1964

CONFIDENTIAL (FOR RESEARCH ONLY)

Dear Colleague:

Thank you for your cooperation in working with us toward an evaluation of "Sets and Systems," a televised in-service series of programs designed for elementary mathematics teachers by the Northeastern Regional Instructional Television Library Project.

We would like you to help us further in the evaluation process by completing the Instructional Activities Survey which begins on page two of this letter. We hope to gain information concerning practices and problems in the teaching of arithmetic and mathematics as these may be reflected in our other evaluation activities for this project.

This instrument has been constructed so as to minimize the time needed for recording your responses. If you wish to make comments regarding this survey, please feel free to do so on the back cover or on a separate sheet of paper. When you have completed recording your responses to all three parts of the survey, please place it in the enclosed postage-paid envelope, seal the envelope, and drop it in any mailbox.

There is no need to sign the survey. Please return all pages at the same time in the envelope provided. The information you give us in this survey will be considered strictly confidential and will not be reported in any manner which will reflect on any single individual or group of individuals.

Your assistance in this educationally-worthwhile project is appreciated. We look forward to receiving your reply.

Thank you.

Sincerely yours,

Donald F. Mills

Donald F. Mills
Director of Curriculum Research

DFM:meb
Enclosures

orm Number OE - 2159

Budget Bureau Number 51 R 448
Approval Expires December 31, 1964

INSTRUCTIONAL ACTIVITIES SURVEY

Part I - Section I: BACKGROUND SURVEY

n this section of the survey, we are interested in learning about your educational and teaching experience background. 'his information will help us make a more meaningful interpretation of the information gained from other sections of he survey. Please mark your responses with an "X," according to the specific instructions given with each question.

. What is your age?

6 1. 24 or under
17 2. 25-29
16 3. 30-34
9 4. 35-39
21 5. 40-44
14 6. 45-49
17 7. 50-54
21 8. 55-59
9 9. 60 or older

. What is your sex?

16 1. Male
111 2. Female

. Which one of the following indicates the highest level you have attained through college credits? (Mark one.)

13 1. Less than bachelor's degree
43 2. Bachelor's degree
21 3. Bachelor's degree plus one year of advanced study
12 4. Bachelor's degree plus two years of advanced study
16 5. Master's degree
9 6. Master's degree plus one year of advanced study
5 7. Master's degree plus two years of advanced study
8 8. Master's degree plus three years of advanced study
2 9. Professional diploma or degree between master's and doctor's
1 0. Doctor's degree

. How many years of teaching experience (excluding student teaching) have you had (regardless of level taught)?

3 1. This is my first year
4 2. This is my second year
6 3. This is my third year
6 4. This is my fourth year
5 5. This is my fifth year
28 6. 6-10 years
24 7. 11-15 years
18 8. 16-20 years
19 9. 21-30 years
17 0. 30 years or more

How many years of teaching experience (excluding student teaching) have you had at the grade level(s) you are now teaching?

6 1. This is my first year
17 2. This is my second year
12 3. This is my third year
14 4. This is my fourth year
14 5. This is my fifth year
33 6. 6-10 years
12 7. 11-15 years
9 8. 16-20 years
4 9. 21-29 years
8 0. 30 years or more

6. At what level do you spend at least 50 per cent (one-half of your working time this year? (Mark one)

___ 1. Nursery (Pre-Kindergarten)
56 2. Kindergarten-Grade 3
49 3. Grades 4-6
12 4. Grades 7-8 (or 9)
1 5. Secondary school (grades 9 or 10-12)
0 6. Rural ungraded school
0 7. Trade or vocational school
6 8. Special classes (remedial reading, etc)
3 9. Administration or supervision
3 0. Some level other than the above (specify)____________

7. How many education courses have you completed at the undergraduate level? (Mark one)

8 1. Less than four courses
12 2. 4-6 courses
13 3. 7-9 courses
18 4. 10-12 courses
4 5. 13-15 courses
6 6. 16-18 courses
2 7. 19-21 courses
2 8. 22-24 courses
11 9. 25 or more courses
52 0. I am not certain of the number of courses

8. How many education courses have you completed at the graduate level? (Mark one)

39 1. Less than four courses
25 2. 4-6 courses
9 3. 7-9 courses
13 4. 10-12 courses
2 5. 13-15 courses
3 6. 16-18 courses
2 7. 19-21 courses
2 8. 22-24 courses
9 9. 25 or more courses
19 0. I am not certain of the number of courses

9. When did you complete your last college-level course in mathematics (including instructional methods courses in teaching arithmetic or mathematics)?

10 1. Last summer (1963)
21 2. Last school year (1962-63)
3 3. Summer before last (1962)
15 4. School year before last (1961-62)
10 5. 2 years ago or more
7 6. 3 years ago or more
9 7. 4 years ago or more
10 8. 5-9 years ago
26 9. 10 years ago or more
15 0. Other answer (specify)____________

Form Number OE - 2159

Budget Bureau Number 51 R 448
Approval Expires December 31, 1964

INSTRUCTIONAL ACTIVITIES SURVEY

Part I - Section II: ACTIVITY INVENTORY

In this inventory, we will try to find out how you describe different activities carried on in the course of classroom instruction. There are no right or wrong answers; we just want to know what you think about certain instructionally-oriented activities.

There is one descriptive word or phrase at the top of each section (three sections per page). You are asked to describe each activity in terms of the pairs of adjective phrases listed below the name of the activity. If you think the adjective phrase at the left of a line describes the subject activity best, please place an "X" in the small box nearest that phrase. If you think the phrase at the right of the line describes the subject activity best, please place an "X" in the small right hand box for the line. If you cannot decide or are uncertain which of the pair of adjective phrases describes the subject activity, please mark one of the two middle boxes for the line. The example for "ROTE COUNTING" has been completed.

ROTE COUNTING

Know	☒	☐	☐	☐	**Don't know**
Do it often	☐	☒	☐	☐	**Seldom or never do it**
Mathematical	☐	☐	☒	☐	**Not mathematical**
Useful	☐	☐	☒	☐	**Not useful**
Not important	☐	☐	☐	☒	**Important**
Boring	☒	☐	☐	☐	**Interesting**
Fun	☒	☐	☐	☐	**Not fun**
Easy	☐	☒	☐	☐	**Hard**
Slow	☒	☐	☐	☐	**Fast**
Good at it	☐	☐	☒	☐	**Not good at it**

In this example, Mrs. Smith indicated she knows how to implement rote counting as a classroom activity. She indicates this activity is used often enough in her classroom to mark the middle box by "Do it often;" not seldom enough to mark the boxes near "Seldom or never do it." She is not sure of the mathematical nature of this activity. She thinks rote counting has some usefulness in the classroom, even though she indicates it is an important activity. She does find this activity boring to her. She believes the activity is fun for children to do; that it is not too difficult a task for them; but, that children are slow to adapt to this activity. In general, she believes she would not do as well as others at using this activity effectively in this classroom. The example for "PLAYING MUSICAL INSTRUMENTS" might be a "warmup" to make the remainder of this survey more easily and quickly done.

PLAYING MUSICAL INSTRUMENTS

Know	☐	☐	☐	☐	Don't know
Do it often	☐	☐	☐	☐	Seldom or never do it
Mathematical	☐	☐	☐	☐	Not mathematical
Useful	☐	☐	☐	☐	Not useful
Not important	☐	☐	☐	☐	Important
Boring	☐	☐	☐	☐	Interesting
Fun	☐	☐	☐	☐	Not fun
Easy	☐	☐	☐	☐	Hard
Slow	☐	☐	☐	☐	Fast
Good at it	☐	☐	☐	☐	Not good at it

By now, you can see the first two pairs of adjective phrases for each subject activity refer to the TEACHING ACT. The third pair of adjective phrases refers to the TEACHER'S OPINION about the mathematical nature of the subject activity. The next three pairs of phrases again refer to the TEACHING ACT. The next three pairs refer to the PUPILS and their reactions. The tenth pair of phrases refers to the TEACHING ACT.

As you have seen from the example given and the example you worked out, you do NOT give more than one answer for each line. Please be sure to mark one space on every line. Please do NOT leave any line blank.

Now try the rest of the problems. Please do not spend too much time on any one line. Your first answer is what we want to learn about. You can work more quickly if you first make sure that you understand what is meant by the activity at the top of the box and then mark every line for that subject activity very quickly.

When you finish one page, go on to the next. When you complete the Inventory, please do not go back and change any of the marks you have made. Please try as many examples as you can.

1. ENUMERATION (CARDINAL AND ORDINAL)

Know	101	19	5	1	Don't know
Do it often	51	53	16	5	Seldom or never do it
Mathematical	86	29	10	0	Not mathematical
Useful	83	31	10	0	Not useful
Not important	1	11	27	85	Important
Boring	8	17	45	54	Interesting
Fun	45	44	29	6	Not fun
Easy	50	53	18	3	Hard
Slow	6	24	60	29	Fast
Good at it	44	60	17	2	Not good at it

2. WRITING STORY PROBLEMS

Know	97	18	8	2	Don't know
Do it often	40	40	26	19	Seldom or never do it
Mathematical	87	26	9	2	Not mathematical
Useful	89	25	8	3	Not useful
Not important	3	4	28	90	Important
Boring	4	10	41	70	Interesting
Fun	54	41	20	10	Not fun
Easy	20	33	45	27	Hard
Slow	28	36	44	16	Fast
Good at it	34	59	22	9	Not good at it

3. USING A PEGBOARD

Know	76	22	9	20	Don't know
Do it often	12	21	22	71	Seldom or never do it
Mathematical	48	39	19	9	Not mathematical
Useful	48	39	20	18	Not useful
Not important	15	25	54	32	Important
Boring	12	28	50	34	Interesting
Fun	38	48	28	10	Not fun
Easy	56	46	20	3	Hard
Slow	14	39	44	27	Fast
Good at it	27	43	40	13	Not good at it

4. ADDITION WITH WHOLE NUMBERS

Know	121	4	0	2	Don't know
Do it often	108	11	2	6	Seldom or never do it
Mathematical	120	6	0	1	Not mathematical
Useful	121	4	0	2	Not useful
Not important	1	1	7	117	Important
Boring	4	11	37	75	Interesting
Fun	62	42	19	4	Not fun
Easy	55	45	20	7	Hard
Slow	5	27	53	42	Fast
Good at it	70	44	9	4	Not good at it

5. DEVELOPMENT OF CONCEPTS OF FRACTIONS

Know	101	13	6	5	Don't know
Do it often	49	42	15	20	Seldom or never do it
Mathematical	110	11	1	3	Not mathematical
Useful	107	13	4	1	Not useful
Not important	3	2	16	105	Important
Boring	3	4	36	83	Interesting
Fun	58	44	16	8	Not fun
Easy	26	42	31	27	Hard
Slow	20	40	42	23	Fast
Good at it	47	59	15	5	Not good at it

6. WORKING WITH MENSURATION FORMULAS FOR AREA, VOLUME, AND PERIMETER

Know	58	26	13	25	Don't know
Do it often	15	20	29	56	Seldom or never do it
Mathematical	93	16	9	3	Not mathematical
Useful	81	17	11	12	Not useful
Not important	9	10	24	77	Important
Boring	9	23	40	49	Interesting
Fun	29	44	32	14	Not fun
Easy	13	29	45	34	Hard
Slow	29	42	37	12	Fast
Good at it	23	42	30	25	Not good at it

7. MANIPULATION OF SYMBOLS

Know	73	23	13	12	Don't know
Do it often	47	33	15	24	Seldom or never do it
Mathematical	87	19	10	2	Not mathematical
Useful	84	21	8	3	Not useful
Not important	5	6	30	76	Important
Boring	6	16	49	47	Interesting
Fun	39	47	25	7	Not fun
Easy	20	39	44	14	Hard
Slow	14	40	47	16	Fast
Good at it	23	48	34	12	Not good at it

8. SOLVING INCOMPLETE DATA PROBLEMS

Know	61	26	11	22	Don't know
Do it often	25	23	30	41	Seldom or never do it
Mathematical	80	20	10	3	Not mathematical
Useful	75	22	12	6	Not useful
Not important	6	8	38	63	Important
Boring	8	19	38	49	Interesting
Fun	31	36	34	14	Not fun
Easy	11	28	48	28	Hard
Slow	29	41	36	8	Fast
Good at it	18	47	31	19	Not good at it

9. FINDING AVERAGES

Know	102	6	4	8	Don't know
Do it often	51	23	14	33	Seldom or never do it
Mathematical	105	11	1	3	Not mathematical
Useful	95	14	4	8	Not useful
Not important	8	4	17	92	Important
Boring	6	16	32	65	Interesting
Fun	45	33	29	13	Not fun
Easy	45	35	24	16	Hard
Slow	17	22	51	30	Fast
Good at it	51	40	19	9	Not good at it

10. WORKING ALGEBRA PROBLEMS

Know	53	23	19	20	Don't know
Do it often	10	18	25	63	Seldom or never do it
Mathematical	93	13	6	3	Not mathematical
Useful	75	22	7	10	Not useful
Not important	11	9	29	65	Important
Boring	10	13	38	50	Interesting
Fun	27	36	29	19	Not fun
Easy	10	22	41	38	Hard
Slow	27	41	35	8	Fast
Good at it	16	30	36	31	Not good at it

11. WRITING MUSIC

Know	34	14	16	55	Don't know
Do it often	4	10	20	84	Seldom or never do it
Mathematical	54	32	12	16	Not mathematical
Useful	48	28	17	19	Not useful
Not important	20	21	37	36	Important
Boring	12	14	40	46	Interesting
Fun	36	39	18	19	Not fun
Easy	14	17	40	41	Hard
Slow	39	41	20	12	Fast
Good at it	15	18	26	54	Not good at it

12. WORKING WITH CONCEPTS OF PROBABILITY

Know	22	22	22	52	Don't know
Do it often	6	15	25	67	Seldom or never do it
Mathematical	63	27	14	7	Not mathematical
Useful	44	34	21	11	Not useful
Not important	10	16	37	46	Important
Boring	13	20	48	29	Interesting
Fun	16	30	41	22	Not fun
Easy	3	15	55	36	Hard
Slow	39	37	31	3	Fast
Good at it	6	27	32	46	Not good at it

Form Number OE -2159

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Approval Expires December 31, 1964

INSTRUCTIONAL ACTIVITIES SURVEY

Part I - Section III: Survey of Problem Areas in Teaching

In this section of survey, we wish to find out from you what some of the difficulties encountered by teachers of arithmetic and mathematics might be. Each of the six questions in this survey were asked of a group of teachers like yourself. Their responses were summarized. You may now help us in completing this task by marking the boxes at the right of the six sets of statements which you believe most clearly indicate the way you would answer the questions posed. If you wish to comment further on any question(s), please do so on the blank pages in the back of this survey booklet.

1. What do you consider to be the most important issues or "controversies" in teaching mathematics and arithmetic in the elementary school today? Please indicate your answers by placing an "X" in one of the boxes at the right of each issue listed.

ISSUES	Not an important issue		Of some importance as an issue		Definitely an important issue	
a. The effectiveness of ability grouping in math classes.	3	5	17	13	45	40
b. Standardization of vocabulary and language structure used in contemporary children's math texts.	6	2	11	8	30	67
c. Parents' understanding concerning contemporary math instruction.	4	4	26	22	42	27
d. Approaches to teaching mathematics.	1	1	9	11	45	59
e. Continuity of math courses from primary grades through high school.	2	1	5	5	23	89
f. Defining the role of "new math" in the school curriculum.	4	4	8	13	37	60

2. Which teaching methods do you find sucessful in teaching mathematics and arithmetic? Which are unsuccessful or less successful? Please indicate the degree of success you do enjoy or that you believe you might enjoy in teaching mathematics by placing an "X" in one of the boxes at the right of each method.

METHODS	Unsuccessful		"Average" success		Very successful	
a. Drill and Practice	0	4	21	39	28	33
b. Concrete illustration or demonstrations of concepts	0	0	2	14	35	72
c. Following procedures outlined in teachers' manuals and guides	2	9	12	43	30	30
d. Providing individualized instruction	0	5	12	24	39	46
e. Assigning homework	7	15	33	46	11	12
f. Providing opportunities for students to question principles and procedures	1	4	16	21	38	46

3. From your point of view, what are the problems for the student in learning mathematics and arithmetic? Please answer by placing an "X" in one of the boxes at the right of each problem.

PROBLEMS IN LEARNING	Definitely not a problem		A problem, but one of moderate consequence		Definitely a problem	
a. Ability to understand abstractions	1	1	15	17	47	46
b. Semantics	0	3	25	35	37	22
c. Quality of children's textbooks	9	15	26	34	20	22
d. Facility with mathematics operations	2	10	23	30	36	24
e. Continuity of course content from grade-to-grade	10	18	20	19	29	30
f. Children's interest in mathematics	18	15	22	30	21	19

4. What do you see as problems in teaching mathematics and arithmetic? Please indicate your response by placing an "X" in one of the boxes at the right of each problem.

PROBLEMS IN TEACHING	Definitely not a problem		A problem, but one of moderate consequence		Definitely a problem	
a. Arousing students' interest in math	22	28	24	24	14	13
b. The teacher's own background and experience in mathematics	8	19	15	22	36	28
c. Accessibility of teacher inservice training programs	22	25	22	19	23	17
d. Accessibility of reference materials	20	23	27	20	21	17
e. Quality of teachers' manuals	24	25	23	20	21	13
f. Quality of children's math textbooks	16	27	17	23	24	20
g. Class time available for actual teaching activities	15	24	19	22	22	25
h. Semantics	5	15	28	35	30	11
i. The teacher's own interest in math	20	19	18	17	23	31

5. What factors do you think should be taken into consideration in planning a mathematics and arithmetic curriculum? Please indicate your answer by placing an "X" in one of the boxes at the right of each factor.

FACTORS	Does not need to be considered or not important		Should be considered as having importance		Needs very definite consideration or very important	
a. Relating mathematics to experiences familiar to the students	0	2	9	13	28	76
b. Helping children to understand the "how" and "why" of mathematical principles and operations	1	1	8	8	26	83
c. Continuity of concept development	0	3	7	10	36	69
d. Basic purposes of the math program	0	3	14	25	25	60
e. Development of quantitative relationships	2	2	10	26	37	50

6. What mathematical principles and practices are included in the curriculum for the grade level(s) you teach? Please answer by placing an "X" in one of the boxes at the right of each group of principles and practices.

	Definitely is not included		Optional inclusion		Definitely is included	
a. Mathematical structures	3	3	6	4	58	40
b. Providing mathematical experiences	0	2	2	8	56	52
c. Mathematical systems	5	9	9	11	48	34
d. Concepts of real numbers	1	7	6	8	50	45
e. Number names	0	2	4	10	42	59
f. Operations on real numbers	5	3	4	6	48	52
g. Writing story problems	7	10	12	22	37	30
h. Operations in Base Ten	9	2	2	6	31	67
i. Problem Solving	2	0	1	10	41	65
j. Working with abstractions	6	6	11	25	47	23
k. Applied number theory	15	15	5	19	41	22
l. Applied basic operations	6	4	7	9	42	49
m. Physically structuring the number system	7	11	7	16	44	27
n. Application of mathematics to everyday life situations	1	3	4	12	48	51

END OF SURVEY
PLEASE RETURN TO

EDUCATIONAL TESTING SERVICE
PRINCETON, NEW JERSEY 08540

THANK YOU

PLEASE PLACE THIS SURVEY IN
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SEAL THE ENVELOPE, AND MAIL TO:

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EDUCATIONAL TESTING SERVICE
PRINCETON, NEW JERSEY 08540

THANK YOU